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GEOLOGY

OF

NEW-YORK.

PART II.

COMPRISING THE

SURVEY OF THE SECOND GEOLOGICAL DISTRICT.

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ALBANY:
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1842.

To William H. Seward,

Governor of the State of New-York.

SIR,

I submit a Report of the Geology of the Second District, comprising the counties of Warren, Essex, Clinton, Franklin, St. Lawrence, Jefferson and Hamilton;

And have the honor to be,

With great respect,

Your obedient servant,

EBENEZER EMMONS.

Albany, *January* 1, 1842.

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PREFACE.

The Survey of New-York was indebted for its projection and execution to a movement in science — a movement which pervaded the entire thinking community. It was one of those natural results which mark the progress of truth, and in itself was an evidence of the progressive intelligence of the human mind.

However much some may be disposed to credit this to individual enterprise, or to the suggestions of an unit in the body politic, still we cannot forbear paying tribute to the collective mind, for a state and condition prepared to appreciate the undertaking. This, however, is scarcely enough; for individuals have done but little more than proclaim the general wish, or have acted only in obedience to an impulse which pervaded community. The New-York survey was only a part of that movement which had taken possession of the intelligent of all classes. All the projects for discovery at home and abroad, in geography, physics and natural history, are themselves parts only of one great series of movements, which date but little farther back than the commencement of the nineteenth century, and which have progressed until the present time.

The survey of New-York, I have said, was one of the same series of scientific enterprises which mark and characterize the times, and which the progressive intelligence of community was prepared to appreciate. In a similar movement, I now remark, we find the agricultural community. The art or science which this community represents, and which is of the greatest importance to the human family, is without doubt destined to that perfection which other sciences have either attained, or to which they are rapidly progressing. In this department, however, we cannot expect a rapid progress; for the methods by which agriculture is to be advanced, require the returning round of seasons. Truth here requires the cumulative evidence of facts often repeated. But that agriculture may partake as fully in the movements of the times as other sciences or arts, and

participate in the discoveries of the present and past, one thing is requisite, viz. that the system of education for those destined to this pursuit should be of a higher grade; it should be more disciplinary, and more directed to secure the perfection of the observing powers. It has, without doubt, been too much the the practice with common or uncultivated minds to overlook this first object of education. They have said that those systems of education which are designed to promote this end were useless, disregarding the ultimate objects; and in asking for reform in the course of instruction in our universities and colleges, the wants and requirements of the mind, to fit it for independent research and generalization, have been overlooked.

I have said that the education of farmers should be such as tends to perfect the observing powers. To know "how to observe," is the first step towards improvement. Now in the education of an agriculturist, both objects specified above may be partially attained. The mind may be in this kind of training, while it is acquiring that kind of knowledge best fitted for the pursuit. To be satisfied of this, let it be inquired, how the mind is affected by the study of chemistry, philosophy and natural history? They all require the closest observation, and the severest scrutiny into facts. The transient shades of color must be observed; the most accurate determination of weight is essential; the almost imperceptible degrees of hardness are to be determined; accurate measures must be applied; in fine, every property, whether transient or fixed, demands observation. In a school where such a system of discipline is instituted, the young agriculturist perfects those powers which are so necessary in every subsequent step of his life. The day dawns to give him an opportunity to observe, and the night closes in upon him still engaged in his watchings. If this is true, how essential that the farmer should learn to observe, that his first lessons should be how to use his eyes. And what will be the consequence? Nothing more certain than that he will use his mind also: it will become active; it comes from the law of necessity.

That an agricultural institute, having these ends in view, may be founded, which shall greatly advance this department, will hardly be questioned. But when institutions have been founded heretofore to subserve some particular interest, it has often happened, that in attempting to make them *practical* schools, we have in reality made them *empirical*. This is always the danger, and it comes from the attempt to evade that course which, in other schools, is disciplinary, and which in truth is their claim to excellence.

The preceding sentiments have been offered, in consequence of the agitation of the subject in the recent anniversary meetings of the agricultural societies. The subject, too, is intimately connected with the late geological survey of the State, by means of which, the munificence of the Legislature has secured an ample and complete collection of specimens of the various kinds of rocks and minerals which compose the materials of our soils, or are found beneath the surface: these specimens are arranged in a cabinet, according to their position in nature: so that they may now be made to serve the interests of agriculture, especially should an institution be established on a proper basis. Submitting these views, I proceed to make a few explanatory remarks in relation to the following report.

The survey commenced in the summer of 1836, and closed in January, 1842. The State was divided into four districts, in areas of nearly equal extent, but without regard to geological structure. The district which was assigned to the author of this Report, included the seven northern counties, with an aggregate area of ten thousand square miles. A very large proportion of this surface is uncultivated, and covered with forests of a dense growth. The conditions under which the survey has been executed were therefore unfavorable in more respects than one.

When the survey commenced, the northern district had received very little attention, except in mineralogy. Several gentlemen who resided in those rich mineral fields, had at that period acquired an extensive knowledge of the localities around them; but no one had determined the relations of the rocks, or made any discriminations even in the classes to which they belong. In the prosecution of the work, the following objects have engaged my attention:

1. The determination of the rocks; their order of succession, superposition and extent.

2. Their mineral associates: the veins and beds of minerals, whether metallic or non-metallic; and the conditions under which they exist.

3. To ascertain the existence of beds of marl, peat, lime, and all the materials used in agriculture or construction.

4. It was my duty to collect eight sets or suits of specimens of each important production, and transmit them to Albany.

5. To collect facts and material for the construction of a geological map.

6. To describe the rocks, and arrange them scientifically.

In addition to the above objects, I have devoted some time to the topography of the Second District. I have ascended and measured most of the higher

mountains; have examined the lakes, and sought out the natural means of communication between different parts of this wide and unsettled territory. At an early period, I commenced a series of magnetic observations, particularly on the variation of the magnetic needle and magnetic intensity. I found, however, that observations of this kind required more time than could be spared from the specified duties of the survey, and they were mostly abandoned.

In the reports which I have made, I have, to some extent, embraced all these objects; having endeavored to keep in view the design of the survey, namely, to make it as useful and practical as possible to the different parts of the district, and to bring to light the resources, such as are available not only at the present time, but those which may become so by future enterprise.

It will be found, on examination of this report, that New-York is well supplied with many natural productions important in the business of life, and that in iron she is particularly rich, and is still in the possession of means to make her rich ores available in consequence of the extent of her forests. Though these possessions are not of a nature to foster our pride, yet inasmuch as they are gifts of Providence, they demand our gratitude, as yielding an abundant supply of materials of the utmost importance to the interests of a growing community, and calling forth the industry, skill and enterprise of our citizens in preparing them for use.

The doctrines which have been advanced in this report, are such as appear now to be warranted by the structure of the field in which the observations were made, particularly those which relate to the origin of primary limestone and metallic veins. Probably the same doctrines will find support in other districts. I infer this from the reports of several geologists whose attention has been directed to the same subject.

In introducing a description of the rocks lying mostly in a belt between the New-York State line and the Hoosic mountain range, I was actuated by a wish to impart a more perfect knowledge of all the lower rocks. In doing this, I am sensible that I have added very little to the amount already given the public in different Essays by Professors Dewey and Hitchcock, and also by the Messrs. Rodgers of Pennsylvania and Virginia. Notwithstanding all that has been done, there is still a great want of local observations carefully made, which will throw more light upon the relations of the masses to each other, and upon the gradations of mineral character. In proposing a separation of these rocks from other systems, I was influenced partly by the opinion, more than once expressed, that

it would lead to a more thorough knowledge of their characters and relations. These rocks have been termed by some of our ablest geologists, *metamorphic.* If I have interpreted this word rightly, I fully believe that they are by no means entitled to this appellation. It will be observed, that in my account of this system, I have labored to prove that they are not the Loraine shales, or in other words, the Hudson-river group, altered by igneous action. Neither are they the parts of the Primary system, as usually located. They may be *primary rocks* in its true sense, and yet differ from those always placed there, as gneiss, hornblende, mica and talcose slates. Whatever may be the final opinion in relation to these rocks, I have no wish to be supported in the views which I have taken of them, unless they are entitled to support. The position the rocks occupy, and the changes to which they have been subjected, are circumstances which have cast in our path many perplexities and obscurities, such as ought to shield any geologist from censure, though he may fall into some sad mistakes. On these grounds I hope to find refuge, if my well-meant labors have either led me into erroneous doctrines, or into an abortive attempt to establish that which has no substantial foundation.

The Second District, in consequence of its primary character, has led me to institute a full examination of those metallic bodies which are found in such large masses in this system. I have sought to bring out their true relations to the rocks which enclose them. In relation to the magnetic oxide of iron, I now believe that I am warranted in supporting the doctrine that it is found under two quite distinct conditions: in one case a rock, a primary mass like granite and primary limestone; and in another, that of a vein. In this respect it bears an analogy with limestone, granite or porphyry: it may be spread out as a rock, or it may be injected like trap dykes and other mineral substances of igneous origin.

In examining the beds or veins of the specular oxide of iron, I have discovered some interesting facts, as they appeared to me; particularly in its association with serpentine and primary limestone. These facts I was anxious to state fully, as they have an important bearing in a practical point of view. The subject, from its importance and interest, requires still farther elucidation.

The sedimentary rocks belong wholly to the lowest position or divisions. According to my observations, they belong to one group; they are strictly of one era or period, as will be seen from the fossils. While I approve of the division of the group into elementary rocks, I see no object which can be gained by a subdivision of the group into two or more groups.

In preparing this report, I have in reality drawn it up in two parts, though this is not distinctly stated. The first part embraces a general description of all the rocks, accompanied with an illustration of many of the principal phenomena which they disclose. In the second part, or the geographical division of the work, I have noticed the peculiarities which are furnished in different parts of the district. In consequence of this method, I may sometimes have been too minute in drawing up my description, and may have repeated the same fact in several places.

It becomes necessary to notice, in this place, what may appear as discrepancies of some parts with others, particularly in relation to the nomenclature. I proposed the words *New-York Transition System*, as the name by which the rocks should be designated. I had previously used the same term: and in fact, having a predilection for the word *transition*, I early proposed the above designation for the New-York rocks. Subsequently it was proposed to strike out the word *transition*, leaving the simple appellation, *New-York System*, which, being shorter, I considered a better name, and hence it was adopted and generally used: but this change was not proposed until the whole of my general account of the rocks was printed. Other changes, too, have been made in the progress of the work, not contemplated in the commencement: several illustrations have been added, particularly the wood-cuts of some of the characteristic fossils, which were not determined on until too late to employ them in the general description of the rocks.

Without attempting to sum up all the results of the Survey of the Second District, I may with propriety state generally, that the rocks, their relations and mineral contents, have been determined over an area of ten thousand square miles; and their geographical boundaries, lithological and palæontological characters, have been ascertained with great exactness. That many interesting facts, however, are yet to be discovered, I have no doubt. The field, in fact, may be considered as only now prepared for investigation, or opened for a more successful exploration; and I hope yet to be able to complete a series of observations, which I have had opportunity merely to commence, particularly those in relation to drift and diluvial action, as well as others in relation to the presence of ores.

In rendering acknowledgements due to those who have promoted the objects of the Survey, they are due first to both of the Chief Magistrates who have successively filled the Chair of State during its progress, not only for official acts

and advice, but for gratuitous aid and influence which could only arise from a deep personal interest in the beneficial results of the Survey. The Hon. Archibald McIntyre, and Mr. David Henderson, are entitled to my warmest thanks for supplying the means of exploring the forests and mountains of Essex. I have received essential aid from Dr. Crawe, of Watertown, in collecting the fossils of the Trenton limestone. Dr. Benton, of Oxbow, has freely assisted me while in his neighborhood; and the same acknowledgment is due to Dr. Murdock, formerly of Gouverneur. Prof. F. Benedict, of the University of Vermont, volunteered his services to complete the exploration of the mountains of Essex, which had been commenced by myself: the result of his labors speaks for itself in this volume. Mr. Redfield has also contributed largely to the same object. I was assisted during parts of two seasons, by my friend Prof. A. Hopkins, of Williams College. He was engaged principally in magnetic observations; and though many important facts were discovered, the series of observations were considered by himself as too imperfect to be published. Mr. Richard Taylor also accompanied me to the iron mines of Adirondack, and from him I received many useful hints and suggestions. Mr. Edwards Hall rendered me efficient service as an assistant during one season. My principal assistant during the survey, has been my son, E. Emmons, Jr. The drawings, particularly the fossils, were executed by him upon wood; and for their accuracy, they are entirely indebted to his skill in delineation. I am particularly indebted to Mr. Patterson, of the State Printing Office, for his unwearied exertions in superintending and correcting the sheets as they were printed, and for important suggestions during the progress of the work. To speak, however, of all who have aided me in the Survey, would require more space than can be spared in this Preface. To my numerous friends in the Northern District, I give my thanks generally for their attentions, and the assistance which they were ever ready to bestow.

EBENEZER EMMONS.

Albany, January 1, 1842.

REPORT

OF THE

SURVEY OF THE SECOND GEOLOGICAL DISTRICT.

CHAPTER I.

OF THE GEOGRAPHICAL RELATIONS OF THE NORTHERN DIVISION OF THE STATE OF NEW-YORK.

That portion of New-York which is north of the Mohawk Valley, may be considered one of the great natural divisions of the State. On the west and northwest, it is skirted by Lake Ontario and the St. Lawrence river; on the north, is the great slope which terminates in the levels of Lower Canada; on the east, is Lake Champlain; and south, the wide and important valley of the Mohawk. It includes ten counties, and embraces an area of thirteen thousand three hundred and sixty-one square miles.

Of these ten counties, the seven following constitute the Second Geological District, viz. St. Lawrence, Franklin, Clinton, Essex, Warren, Hamilton and Jefferson. The three remaining counties, viz. Herkimer, Lewis and Saratoga, though not embraced in the Second Geological Section, are so intimately related to the others, that I shall have frequent occasion to refer to them, as they severally embrace portions of the same formations. The greatest length of the Second Geological District is from Glen's-Falls to the northwest corner of Franklin county, and is about one hundred and thirty-five miles. The greatest breadth, or the distance across the district from east to west, is not far from one hundred and thirty miles.

The northern division of the State, as defined above, constitutes an entire whole, or it is a territory which is unsusceptible of farther subdivision; or it may be considered as an insulated portion of the State, bordered by three great valleys, the valley of the Champlain on the east, that of the Mohawk on the south, and the St. Lawrence on the west, northwest and

north. Towards the valleys the adjacent country slopes, presenting, in this respect, a general coincidence with the dip of the rocky strata.

Topographically considered, the second section presents one great range of highlands, which stretch diagonally across the country, from Little-Falls on the Mohawk to Trembleau Point on Lake Champlain.

Geologically considered, it is one great uplift, with gradual but unequal slopes on all sides, which, if we leave out of view minor irregularities, may be compared to an egg with its major axis to the north.

It will be perceived from this brief topographical sketch that there cannot be, strictly, an anticlinal axis or ridge; for though the main range of highlands extends across the country from Little-Falls to Trembleau Point, still the country does not really slope from a continuous ridge, but rather towards all the valleys which surround, almost entirely, this division of the State: there is a *culminating point*, instead of an *anticlinal axis*, in the region of the greatest elevation from which the several slopes proceed.

In consequence of this arrangement, there is a general water shed draining the country in the direction of all the points of the compass. That such is the formation and structure of the country under consideration, may be inferred by an inspection of the maps of this region, on which the rivers will be seen to take their origin in the vicinity of this culminating point, or greatest elevation, and to flow, some to the east, southeast and south; others, to the west, northwest and north. I have already said that the slopes are unequal; thus, proceeding from Port Henry, on Lake Champlain, to the west, the summit level is gained in the vicinity of Mount Marcy in about thirty-five miles. From this level to the St. Lawrence river, it is not far from seventy-five miles. From the Mohawk Valley it is about eighty to Racket lake, and from thence north to the levels of Lower Canada it is about seventy.

The view, as now presented, exhibits the topography in its simplest aspect. It is not, however, complete or perfect, as it does not present it in the light it would appear to a spectator placed upon one of the most commanding eminences. Thus situated, the whole country appears studded with a multitude of peaks, which, on the first inspection, are irregular and without order; but by carrying the eye over a wide territory, an orderly disposition may be made of the mountain masses.

The masses here referred to may be arranged into the following chains or ranges, each of which pursues a course from the southwest to northeast. In the description of those ranges, it is convenient to commence with those situated to the east, and proceed in order as they occur to the west.

The most easterly range within the State rises to the north of Saratoga, and pursues a northeasterly course through the southeast part of Warren and northwest corner of Washington counties, passing between Lake George and Lake Champlain; it terminates to the south of Ticonderoga. The most remarkable and prominent part of this range is that portion of it situated between the lakes already referred to, where it is in high, broken, precipitous cliffs. It is known as the *Palmertown Mountain Range*, or *Black Mountains*. It is sometimes called the *Tongue Mountain Range*.

The Kayadarosseras is the range next west of the preceding; it rises in Montgomery county, pursues a course parallel with Lake George, which bounds it on the west; it terminates near Crown-Point and Port Henry on Lake Champlain. The highest part of this range is in Schroon, near Lake Pharaoh; and hence the high and imposing summit near this lake is called Pharaoh's Mountain. The succeeding range rises north of Johnstown, and passes through Athol, Johnsburgh, East Moriah, and terminates at Split Rock. Crane's Mountain in Athol, near the corner of Johnsburgh, is probably the highest mountain in the range, attaining an elevation of three thousand feet.

The West Moriah range rises far south in Montgomery county, and pursuing the same general course, it becomes a high lofty range west of Pondsville, where it attains its greatest elevation; it declines gradually in its course, and finally terminates at Willsborough on the lake. This range lies between Hope and Lake Pleasant, and upon an average is about nine miles wide. The highest point is Dix's Peak.

The most considerable of the mountain ranges commences at Little-Falls, and passes to the west of Lake Pleasant, and attains its greatest elevation in Keene, in the west part of Essex county. Its termination is on the lake shore at Trembleau Point, a few rods south of Port Kent. The highest part of this range consists apparently of a group of insulated mountains. These constitute the Adirondack Mountains, or *Adirondack Group*. I embrace in this group, Mount Marcy, McIntyre, McMartin, Santanoni, Henderson, Boreas and Taylor's mountains. It is intended to include all those which are composed of hypersthene rock, which will be described in the following pages. The whole range may, with great propriety, be called the CLINTON RANGE. The most elevated peak is MOUNT MARCY, whose summit is just upon the region of perpetual frost. By barometrical measurement it is 5,467 feet high.

It will be perceived from the preceding, that in going from east to west from Lake Champlain, from near Ticonderoga, these ranges which I have enumerated must necessarily be passed before reaching the table land from which the country declines. After this is attained, however, the descent to the St. Lawrence, west, is not over ranges of mountains as on the east, but the slope is more gradual and regular, and much longer. Besides, it is even difficult to make out clearly distinct ranges at all, though there are numerous disconnected ridges, and some important groups of mountains. Among these is MOUNT SEWARD, situated in a cluster which forms an imposing mass as seen from Long Lake. Whiteface is a grand mountain, quite insulated, rising from the eastern shore of Lake Placid; from its summit is the most imposing mountain view of any in the northern section of the State. Still farther northwest, the hills of Chateaugay appear to terminate this mountain system by an abrupt descent into the plains of Lower Canada. The northern slope gives a full view of all that level triangular area between the Sorel and the St. Lawrence. The abrupt termination of the mountain ranges upon the lake shore, and as I just noticed in the plains of Canada, forms a very remarkable feature in the mountain system of the north. The Green Mountains of Vermont run onward through Lower Canada as far as the eye can trace them in the distant horizon, while those of the Adirondack rise suddenly from the Mohawk and Hudson valleys, and terminate equally abrupt either upon the lake shore or in the levels of Lower Canada. Not

even an outlier is to be seen which would go to show the gradual extinction of the force which upheaved them ; the whole force seems to have been concentrated upon the space between the Champlain and the St. Lawrence. We have indubitable evidence of this mighty and concentrated force in the magnificent cliffs and precipices, which are continually arresting the attention of travellers.

To the southwest of Racket lake, this broken range appears to assume an east and west direction, and to consist of two parallel ranges, forming between them an important valley, in which are situated the Fulton chain of lakes, and through which there is a feasible route for a road by which to gain the table land of the Racket, and thence any point on Lake Champlain.

As I have already remarked, the western and northwestern slope to the St. Lawrence is long and not abrupt, as may be proved by the sluggish movements of the rivers which take their rise upon this table land, some of which are boatable for long distances. The country, it is true, is somewhat broken by ridges of a limited extent, but the characters are materially changed from what they are upon the eastern and northeastern slope.

Before I close my account of the mountain ranges of the north, it is necessary to notice one feature which they all present. I am not prepared to say whether this is peculiar or remarkable ; it is, however, interesting, and is worthy of attention.

The fact which I wish to present is, that the mountain ranges do not present a uniform, unbroken ridge, but are made up of subordinate short ridges, whose axes are oblique to the axis of the main range in which they are situated. The axes may be called the major and minor axes of the range ; the former lies in the principal direction which the range pursues, which is from the southwest to the northeast ; the latter in the direction of the short interrupted ridges, which is from the southeast to the northwest. I shall not attempt to explain the mode by which such an arrangement was produced, though it is unquestionably due to the mode and direction by which the elevating force operated at the time of the uplift.

I may remark, however, that it is to this peculiarity that the difficulty arises in determining the range to which many of the mountains belong, or in attempting to reduce to order the several chains which traverse this portion of the State.

Valleys.—The Second Geological District is penetrated by a few valleys only, and these are long and narrow ; and as in all mountainous districts, so in this, they partake of the nature of gorges, having abrupt sides and very little width. Their number and direction may be determined by the rivers laid down upon the map. The valley of the Hudson river is the longest and most important ; the Schroon branch runs through it ; and although it is high for a valley of its length, yet it presents an accumulation of diluvial gravel and rounded pebbles throughout its entire length, a hundred feet or more above the banks of the river. Another valley extending from Corinth to the head of Lake George, connects the plains of Saratoga with the valley of this lake and Lake Champlain.

But the valleys to which allusion has already been made, require a more detailed account. I refer to those which surround the Second Geological District. They contain a great extent of arable lands, and receive the drainage of from eight to ten thousand square miles, princi-

pally from the northern highlands of New-York. It is this great extent of drainage from an elevated wooded region which gives such a constant and regular supply of water, and it is this which ensures its continuance. If, however, we look forward to a time when a large proportion of this wilderness shall be under tillage, there is some probability that quite a different state of things may exist in this respect, especially as it regards the Hudson. This river rises wholly under the shadow of forests, wild and uncultivated. If now those forests were to be replaced by pastures or open fields of any description, the quantity of rain which now falls would be materially diminished, especially during midsummer; or if it should not be diminished, the evaporation from the surface would be greatly increased, so that the result would remain the same under either condition. Less will flow in the natural channels, and the supply for navigation may be so far diminished as to prevent, or if not prevent, greatly impede the navigation, and interfere with its employment for moving machinery, or the various purposes to which water is applied.

The most important valley of the Second Geological District is the Champlain; but only a small proportion of this belongs strictly to New-York: still I have considered it as necessary to investigate its physical as well as its geological relations as a whole. The length of this valley is one hundred and eighty miles, if it is to be considered as extending to St. John's; but it appears to open into the valley or basin of the St. Lawrence twenty miles to the south. The greatest depression of this valley is between Westport, Burlington and Port Kent. By sounding close to the edge of the perpendicular rocks about four miles north of Westport, I found the depth to exceed three hundred feet. By soundings at other places in this part of the lake, its depth has been found to be *six hundred* feet; it extends therefore five hundred feet at least below the level of the ocean. Situated as the lake is, entirely upon the western side of the valley, its bed must be regarded as a deep chasm principally in the primary rocks; for from the lake shore upon this side the slope is abrupt along the whole portion where the several mountain ranges reach it, or excepting those portions of it which are bordered by the minor valleys. The character of the slope upon the east side is quite different from the west; that is, it is longer and much more gradual in its descent; it comprehends most of the valley. In a direct line, or a line perpendicular to the course of the lake and the Green Mountain range, it cannot exceed twenty-five miles, and probably the average width of this valley is about twenty miles. At many places the lake is bordered by steep banks composed of clay and sand, the greatest height of which is about one hundred feet. It is not my purpose, in this place, to consider the nature of this formation or its age, but it is proper to remark that it is marine, as at many points it furnishes an abundance of fossils belonging to those species which are now inhabitants of the sea on the Atlantic coast; those too which belong to the same latitudes. Thus, I have found the Mya arenaria, Mya truncata, Natica clausa, Tritonium anglicum, Tritonium fornicatum, Scalaria grœnlandica, Saxicava rugosa, Tellina grœnlandica, Balanus miser, Pecten islandicus, Terebratula psittacea, Modiola ——, and several other shells, amounting in all to about twenty species; all of which, as has been remarked, belong to the present Atlantic shore. We may therefore consider the sediment of this valley

as quite recent, and, in addition to this, as having undergone but little change since the marine occupants gave place to the lacustrine.

On the New-York side there are several small and unimportant valleys which open into the Champlain ; the most important are those of Lake George, which has already been spoken of as extending to the plains of Saratoga, the Bouquet, Ausable and Saranac. The Bouquet is narrow, and runs nearly in the direction of the lake about eight miles, and along the junction of the primary with the transition rocks. The Ausable is much more important, and is geologically interesting for the gorges in the Potsdam sandstone through which the Ausable flows. The river flows near the southeastern side of this valley, and it is not improbable but it would be proper to consider the Ausable and Saranac as but one valley. Considered as one, it extends twenty miles west of the lake, and north till it terminates in the valley of the St. Lawrence. It lies in the angle formed by the Great Adirondack on the south, and Lyon and Whiteface on the west and northwest. It extends therefore from Keeseville to Champlain, and from Plattsburgh to Redford. Geologically, this valley is important and interesting, particularly as it furnishes a better developement of the lower transition rocks than any other part of the State. It is only here that we find the series complete ; the phenomena too of uplifts and fractures are finely displayed ; in addition to which, all the elementary principles of geology may be found illustrated in a field quite accessible.

I have only to notice one other feature in the valley of the Champlain, viz. the obliquity of of its subordinate valleys. Thus, on the west or New-York side they open to the northeast ; on the east, nearly to the northwest ; though as it regards the latter, their course coincides more nearly with the direction of the Green Mountain range ; thus, the valley of Otter creek coincides very nearly with that of the lake, or to a north and south direction. These facts, it is true, are unimportant in themselves, and they are only noticed for the purpose of showing more clearly the slope and convergences of the valley ; it is only by these facts that this structure can be demonstrated.

Age of the Valley of the Champlain.—The question concerning the age of valleys is quite as important as that of the mountain system ; in many instances these two inquiries are connected and inseparable from each other, or the determination of one settles that of the other. Though it is difficult to determine the question under consideration with much exactitude, still there are two or three facts which are important : 1st, It is a very ancient valley, a fact which is proved by the organic remains of the clays and sands which form the present floor of the valley. 2d, By the smooth and polished surface of the rocks which compose the ancient floor upon which the clays and sands of the post-tertiary, (as the formation has been designated,) were deposited ; for we cannot regard them as having been wholly formed by sudden and violent movements of the loose materials upon the surface : the whole phenomena is one of moderate force, combined with one of power, but yet of long continuance.

The ancient floor of this valley is formed by two classes or systems of rocks : 1st, The *primary*, principally gneiss ; and 2d, the lower transition or rocks of the Champlain group, as they are denominated in the subsequent pages. The order of events connected with the

formation of this valley may be stated thus: 1st, The primary rocks, which constituted the floor of an ancient ocean of an unknown extent. Upon these were deposited the sandstones, limestones and shales of the Champlain group; thus far the series of rocks appear to be whole and perfect, or without breaks; but after the completion of this group, the ocean retired, and they became the surface rocks. Subsequent to this, an elevating force deranged the horizontality of the masses, fracturing them extensively in the line of the present valley, and raising them above the waters of the ocean. This line of elevation and of fracture runs close upon the western shore, and merely breaks off the western edges of the transition. In the third place, we find a current or flood of waters to have swept through this valley, and to have removed to a great distance the loose materials of the surface, and by their means to have worn down and polished the surface of the rocks which were exposed. 4th, We find this valley again occupied by an ocean, in which deposites were again accumulating, principally aluminous or of clay, but mixed with calcareous matter in the middle portion and siliceous in the upper. This state of things did not exist long, for the marine relics are few, and the formation deposited limited and thin, probably not exceeding one hundred feet. In its turn this formation was elevated, and became exposed to currents of water bearing along rocks and stones, being in some places entirely swept away; in others, only the sandy portion or the upper part; in others it remains entire, especially where it was protected by jutting rocks; thus the stiff blue clay of the inferior portion, the yellow and brownish of the middle, and the sand of the upper, all remain undisturbed. It is in the two last that we find the modern shells principally near their junction. The last sweeping of this deluge of waters formed the present boulder system; and we find the latter always above the former, or post-tertiary. Such have been the vicissitudes of this beautiful valley: twice have the waters of the ocean reposed upon its bosom, and twice has it been swept, as it were, with the besom of destruction. For a long period after the deposition of the Champlain group, it remained above the watery element, or during the whole period required for the deposition of the New-York transition system, the old red, the carboniferous, the secondary and the great tertiary; after which, for a short period, it was once more under the sway of Neptune, and the monsters of the deep once more took possession, and the iceberg floated upon its waters. But this state was to be transient, for it was already fitted for the abode of man; the waste was to be reclaimed, the time had already come for man to assume the power, and erect his temples in the vale. How long the present floor of this valley has existed, cannot be told with any exactness approaching to a demonstration, but it is manifest that it is comparatively recent; for the materials being soft, would ere this have been entirely removed, and the beds destroyed, had they existed during the epochs of the eocene tertiary, especially in those places where they are exposed to abrasion by rains and floods. Even deep furrows are worn annually in the sands and clays, and they are perceptibly diminishing in extent.

St. Lawrence Valley.—New-York may be said to be situated centrally in this great valley, and to be placed in that position which commands the commerce and trade of the better portion of this immense region. The Second Geological District, however, embraces only a

small part of this valley; an area of seventy miles by sixty may be taken as its probable extent; or in other words, it only comprehends three counties, Jefferson, St. Lawrence and Franklin. They form the north and northwestern slope of the valley, which is of an even grade of ascent, and mostly free from abrupt steps, from the St. Lawrence river to the table land of the Racket. The rivers draining this slope are Black, Oswegatchie, Indian, De Grasse, Racket, St. Regis and Salmon rivers. They carry down an immense amount of water, but make no perceptible addition to the deep and majestic flood of the St. Lawrence. The remarks already made of the Champlain valley apply to this; the banks of the St. Lawrence are formed in many places of fractured strata, as those of Lake Champlain; they support too the same post-tertiary to which allusion has been made; and it has suffered the kind of abrasion and changes which has resulted in wearing and polishing its rocks.

The rocks too belong to the Champlain group; thus, upon the southeastern side, from near Oswego to the north of Quebec, the series rise no higher than the gray sandstone above the Lorrain shales. Primary rocks, as granite and hornblende, compose a part of the Thousand Islands; but passing those islands to the north, the series of the transition commence with the Potsdam sandstone, and form a continued series up to the grey sandstone, comprehending the Potsdam, Calciferous, Birdseye, Trenton, Lorrain shales and grey sandstone. In Lower Canada, in the districts of Missisque, Shefford and Drummond, the talcose slates and limestones of the Taconic system prevail, being a continuation of the same rocks as compose the western slope of the Green mountains and the Taconic range.

On the northwestern side, also, the Champlain group forms the predominant rocks from Kingston to the Falls of Montmorenci. What is remarkable, and well worthy of notice, is the absence of the rocks of the Taconic system upon this side of the river; the Potsdam sandstone resting upon the primary limestone, granite and serpentine, as in the central part of the county of St. Lawrence. Thus on both sides of the St. Lawrence, in a section passing through Gouverneur, Black lake, Brockville, to Lyndhurst, Beverly, &c. Upper Canada, the association of rocks is precisely the same on both sides of the river.

Following down the St. Lawrence, it has been observed that the Champlain group continue to the north of Quebec. But below, from some point not precisely known, the series is carried up higher in the transition; for at the island of Anticosti, the pentamerus lime rock predominates, and bears the same fossil, the Pentamerus galeatus, and with the same general characters as the same rock presents at the foot of the Helderberg. The sandstones, shales and plaster beds of the Ontario group, occur in the islands of the Gulf of St. Lawrence. To the east is the carboniferous formation of Pictou and Chepody bay in New-Brunswick. The same series of rocks occur therefore to the northeast as at the southwest, thus placing New-York between two coal basins, having within her limits a portion of the series of both. Thus the slope from the Thousand Isles and the Mohawk Valley exhibits the commencement of the rocks, which terminate in the north line of Pennsylvania in the carboniferous rocks; while those north of the Thousand Isles belong to the coal system of New-Brunswick. This general view of the topography, phenomena and range of rocks of the great valleys must suffice

for the present. The valley of the Mohawk being comprehended in another district, will not require from me farther notice.

I shall complete this general view of the Second District, by a table of heights of some of its most important points. The heights have been obtained principally by means of the barometer, a few by the theodolite, others by estimation or comparison; conceiving that, even by the latter mode, in the absence of means for correct determination, is better than none, inasmuch as they are considered in all instances to be within one hundred feet of the truth. The general elevation of the country is thereby approximated, and we are able to form a better conception of its features.

TABLE

Of Heights of some of the most important points in the Second District, above tide.

	FEET.		FEET
Lake Champlain,	93	Mount McMartin.	5,000
Summit of the Champlain Canal,	147	Mount McIntyre,	5,183
Bulwagga Mountain,	1,260	Mount Marcy,	5,467
East Moriah Four Corners,	790	Lower Saranac Lake,	1,527
Bald Peak, Westport,	2,065	Upper Saranac,	1,567
Raven Hill, Elizabethtown,	2,100	Stoney Ponds,	1,536
Pass of the road summit between East and West Moriah,	1,546	Foot of Racket Falls,	1,538
Pondsville, W. Moriah, in the Schroon Valley,	1,117	Long Lake,	1,575
Pass of the range to Johnson's,	1,375	Forked Lake,	1,704
Dix's Peak,	5,200	Racket above Forked Lake,	26
Nipple Top,	4,900	Racket Lake,	1,731
Schroon Mountain,	3,200	Eighth, Seventh and Sixth Lakes of the Fulton chain,	1,720
Pass between Johnson's and Adirondack,	2,592	Fifth, Fourth, Third, Second and First of the same chain, (approx.)	1,645
Boreas River Bridge,	2,026	Lake Eckford of the Eckford chain,	1,791
Boreas Mountain,	3,726	Owl's Head,	2,706
Hudson River Bridge,	1,810	Owl's Head above Long Lake,	1,121
North River Mountain,	3,600	Rich Lake,	1,547
Lake Sandford,	1,826	Newcomb Lake,	1,698
Adirondack Iron Works,	1,889	Adirondack Pass,	2,817
Lake Henderson,	1,936	Mount Seward,	5,100
Lake Colden,	2,851	Mount Emmons,	4,000
Avalanche Lake,	2,900	Santanoni,	5,000
Highest source of the Hudson,	4,747	Taylor's Mountain,	4,500
Whiteface,	4,900	Summit of the northern route of the Champlain railroad,	1,089
Lake Pleasant,	1,500	Summit of the southern route of the Champlain railroad,	1,737
Tupper's Lake,	1,545	Ogdensburgh above Lake Champlain,	143
Preston Ponds,	1,700	Wallface Mountain,	1,000
Cranberry Lake,	1,570		
Height of the pass between the Schroon and Ausable,	2,756		

CHAPTER II.

Some of the objects of Geology stated. — What was known of the geology of the Second District at the commencement of the survey. — General views of the primary and sedimentary rocks, and an outline of their boundaries. — Potsdam sandstone, one of the most ancient of the deposits from water. — Classification. — Term Transition; no valid objection to its use.

The topography of the Second District having been given in as much detail as seems to be required, I shall now proceed to the consideration of those subjects and inquiries which are more intimately connected with the objects of the survey. In order that no misapprehension may exist as it regards those objects, I propose to state them under the following heads: 1st, To determine the kinds or the species of rock; 2d, Their arrangement or order of superposition; 3d, The ores and minerals which are their associates; 4th, Their agricultural characters; 5th, Their value as objects of merchandise; and 6th, Their extent or geographical range.

The objects which I have now enumerated do not, however, comprise all within the field of geological investigation, or cover the ground which is conceded to geological inquiry; they, it is true, are numerous and highly important, and stand in intimate connection with the wants of civilized life, and become more and more so with every step in the progress of society; yet, in addition to these, there are other facts and inquiries in geology which do not stand second to any in interest and importance, in the field of human research. The inquiries here alluded to, relate principally to the history of the earth, the organic beings entombed in its solid rocks, as well as the present occupants of its surface, including even man; and these, in consideration of the interest and the bearing they may have on the decision we may make on some of the most interesting questions which daily present themselves to us, will form subjects of discussion and reference, whenever they naturally come up, and when they flow from facts which have fallen under my immediate observation.

Before I proceed to these subjects, which, as I have just stated, form the principal objects of the survey, I propose to state, briefly, what was known of the geology and of the topography of the Second District, when the survey was undertaken. This appears to be not only just and right to those who interested themselves in the work, but also to myself; inasmuch as the facts and discoveries which have been made public in the annual reports, in verbal and written communications, have been copied into many of the publications of the day, without a notice of the source from whence they were derived. This is stated, however, not in the way of complaint, but for the purpose of setting the matter right, though it may be considered by some as one of small importance. Previous to the year 1837, nothing exact was known

of the geology of the Northern District. Mr. Eaton, who was the oldest laborer in geology in New-York, had not extended his observations far into this field. He had, however, represented the McCombe Mountains as composed of ranges of gneiss, extending from the valley of the Mohawk to the Provincial line, and the intermediate valleys, of limestone extending along their bases and around their northern extremities ; and the whole section as being composed of two principal formations, a carboniferous slate, denominated primary, and a calcareous formation, denominated secondary.

It is sufficiently evident that all this was imaginary ; it is even difficult to conceive how imagination could have carried even a partial observer so far from the truth.

In the 19th volume of Silliman's Journal, a paper on the geology and mineralogy of the county of St. Lawrence was published by Mr. Finch. In this paper there is a brief account of the rocks of this county ; the Potsdam sandstone was spoken of as a transition rock, and the calciferous sand-rock of Eaton as a siliceous limestone ; but their geological position does not appear to have been known to the author. A very good account of the minerals is given in that paper. In addition to this, however, several gentlemen, previous to Mr. Finch, had explored this field mineralogically with success ; among whom were Dr. Crawe of Watertown, and Dr. Murdock of Gouverneur. Much more, therefore, had been accomplished in mineralogy than geology. Other regions which had also been explored, were those of Lake George and the vicinity of Willsborough ; and many of the minerals of those primary rocks were already well known to the public. The beautiful labradorite too had been discovered by Mr. Henderson, near the site of the Adirondack iron works.

But as it regards the geology of the Second District, nothing had been really settled or accomplished. Gneiss, granite, limestone, sandstone and iron, it is true, were known to exist in this section ; but their relations, their extent, their value as mining rocks, and various other facts and inquiries remained unknown. The field was therefore new, and I was obliged to commence my observations without a guide or a starting point. To those who may now commence the study of the rocks of this region, it may appear perfectly simple ; and it may be that only a few days, or weeks at most, will be required to obtain possession of the general arrangement and relations and characters of the rocks. The determination of these points, however, has required a multitude of observations both within the district and out of it, in order to establish those facts beyond a doubt, far greater probably than one would suppose, who is unacquainted with the nature of those inquiries.

As it regards the topography and general features of this portion of the State, I may also justly remark that they were subjects as little known as the geology. The mountains were estimated, or rather given in the various works of the day, as varying in height from 500 to 2000 feet. Those statements may be compared with the actual results which have been obtained by barometrical measurements, the correctness of which have been verified in several instances by levelling, in surveying for the northern railroad route, by competent engineers. In obtaining some of the heights of elevated points in this region, I have been assisted by Mr. Redfield of New-York city, and Prof. F. Benedict of the University of Vermont. The latter gentleman, at my request, devoted considerable time to the prosecution of this object, in the

interior of the wilderness. Many of the observations in the report for 1840 were highly interesting and important. In estimating the labor required for the establishment of doctrines or principles in geology, or any of the classificatory sciences, only a small amount of that which has been required for those ends can appear connected with the result, unless the details are given in the form of a journal; the reason of this is, that it frequently requires as much labor to establish a negative as a positive result; all of which, as it concerns the former, must necessarily go for little or nothing; it is only the latter which goes upon the record. The non-existence of gold in primary limestone, required as much labor, and a series of observations as complete and full, as those which have determined its position in the talcose slate. Such has been the case in the prosecution of many inquiries relating to the geology of the State; and were details given in full in many instances, it might appear, to some, that time had been wasted in an unprofitable pursuit; while, in reality, the subjects in question would have been left in an uncertain state, if left unprosecuted to the extent to which they have actually been carried.

With these general remarks and statements of what was known of the geology of the Northern District, at the commencement of the survey, I shall proceed with that part of my report which is usually termed *Scientific Geology*, or that division of the science under which the masses composing the accessible portions of the earth are classed and described in a language more or less technical, and their relative positions assigned them according to principles which have been established by observation.

Technical descriptions, however, will only be given where clearness and precision require them, or where popular descriptions would be likely to lead to error and misapprehension; and conceiving that the report is intended to benefit general readers, or those who have not made geology a particular study, such a course seems to be called for. We are relieved, however, from much embarrassment of this nature, in consequence of there being, comparatively, but few scientific or technical terms in this department of knowledge. The method which I shall follow in describing the rocks of the Northern District, will be that of the ascending order; an order which has usually been adopted in this country, and one which appears to be best adapted to impart distinct and accurate views of the chronology of events which have been connected with the early history of the earth. Whatever may be the best method in a general treatise on rocks, there can be but little doubt that this which I propose is best suited to the geology of the district, and which will enable me to give a clearer account of the subjects I have been called upon to investigate.

In order that the views of the geology of the Northern District may be simplified, we may consider the rocks as belonging to two classes: the crystalline, or primary in the Wernerian sense of the word; and the sedimentary, or those which have been deposited from water. The former occupy the more central parts of the district; they rise into high and precipitous mountains; while the latter occupy a belt, which borders the preceding on all sides, and from which they usually decline. This belt is, however, imperfect, if we confine our observations solely to New-York. Thus, at several points upon the eastern side, the primitive ranges, when they extend to Lake Champlain, break through it; in many places it is quite narrow,

or it is imperfectly defined in consequence of the operation of causes, of which I shall have occasion to speak in the sequel. Our views may be simplified still farther, by imagining the entire primary mass as having been formerly an island, around whose borders the sedimentary rocks were deposited; and as we recede from those ancient shores, whether to the north, east, south, or west, we pass from the older to the newer deposits. In a former report, I suggested that the Potsdam sandstone, which rests in this district upon the primary, is one of the oldest sedimentary rocks of the globe. This view seems to be borne out by the fact, that it underlies all the rocks of the Silurian and Cambrian systems, if we leave out of view those which are called metamorphic.

All the observations upon this rock have resulted in establishing the fact, that it is beneath the Cambrian system of rocks, which are the lowest and oldest in the English series. It is, perhaps, unnecessary to speak in this desultory way of those rocks, which are to be the special subjects of remark. I do so merely for the purpose of showing the sudden transition from the highly crystalline rocks to those which are merely earthy deposits, and which are composed of the abraded particles from previously existing masses.

The classification which I propose to adopt in this report, is that which appears to be generally approved of, and followed in this country, viz. that which places the rocks under the following heads: *Primary*, *Transition*, *Secondary*, *Tertiary*. I can see no valid objection to retaining those names for the first and great divisions, though I am aware that they are not in repute with many who sway public opinion; still, so far as substitutes have been proposed, they appear to me quite as objectionable as the old terms. The truth is, so long as descriptive names are inapplicable, and since rocks coalesce or graduate into each other, so much so at least as to prevent our drawing lines of distinction between adjacent masses, it appears better to retain those names which have become familiar, if not classical, than to encumber the science with those which are new. Take, for illustration, the terms *transition* and *silurian*: the former is said to be objectionable for two reasons; the first is, that the limits of the rocks which have been classed under the word, have not been settled. Admitting the fact, has not the extent and meaning of the word *silurian* to be determined arbitrarily? Is it then not a question whether it shall include the beds of passage from the Silurian rocks into Old Red or Devonian system?* If so, then the same objections apply equally to both. The other objection to the word *transition*, is, that it involves theoretical views which are questionable; but who ever, nowadays, thinks of the theory which led to the selection of this word as a name for a class of rocks. If only those names were to be rejected to which this objection applies, science would be thrown at once into a state of confusion and disorder; for more than one half of the names of things in natural history have been given under notions as erroneous as the word *transition*; but it does not follow that the error which led to the selection of the name,

* Difficulties as great, if not greater, meet us in defining the limits of the silurian and cambrian rocks; in fact, the cambrian appear to be, in part, silurian. In addition to these objectionable points in the general use of those words, we have rocks highly fossiliferous which do not belong to either system, as they now stand defined.

is propagated and conveyed down from one generation to another. The name remains, but the error is either forgotten, or at least ceases to mislead. The only duty, therefore, in relation to those names which have been so long in use, is to restrict them to certain limits. This being done, we may subdivide those rocks into groups, or series, giving those names to the groups, or series, which shall be derived from that section of country where they are well developed; our nomenclature may then be completed by giving local names to individual rocks where it is necessary, observing to select those places at which they are all the best developed. In following this plan, we are in less danger of overrating the value of a name, or falling into error by mistaking a name for an idea, or an idea for a fact.

I may here state that the upward limits of the Transition class may, with great propriety, be placed at the Old Red Sandstone, or Old Red system, or Devonian, as it is often termed; it embraces the rocks between the primary and the old red, a limit which can generally be defined with sufficient accuracy and precision.

Adopting the names for the principal divisions of them as now proposed, I shall follow still farther those subdivisions of the primary which have also been long in use, and which have received the sanction of some of the most eminent geologists. Those subdivisions are as follows: *Unstratified, Stratified* and *Subordinate*. The two first must ever remain as well marked divisions, which it will be useful to observe; the term *subordinate*, applies very well to a class of rocks which appear irregularly among the greater masses, but which are always limited in extent; and they are not found occupying the same relative position, but repose sometimes upon the primary, and sometimes upon the transition, secondary, or even tertiary.

Of the Primary Formations of the Northern Division of the State.

The Primary formations occupy by far the largest part of the area between Lake Champlain and the St. Lawrence river. They constitute not only all of that portion which is the most elevated, as the mountains in the vicinity of the head waters of the Hudson, Ausable, Racket, Black and St. Regis rivers, but also large tracts of the less elevated portions in the immediate neighborhood of the great valleys, as the Champlain, Mohawk and St. Lawrence. As a whole, or as a class, they are well characterized; and we find but few places where there are gradations of the Primary into the Transition in this District, few rocks which can, with propriety, be termed *metamorphic;* they, however, present a great diversity of aspect and of character, and in this respect they form an interesting assemblage of rocks.

I have just observed, that there are few transitions of the primary into the sedimentary rocks. There are, however, many transitions among the primary masses themselves; and we often find intermediate ones, which are with difficulty placed under appropriate names. This is not, however, a matter of much consequence; it is a result, or a fact, which we should expect, when we consider the origin of the primary rocks, and the agencies to which they have been exposed. In studying, or describing them, it is important to keep this fact in mind.

Classification of the Primary Rocks, comprehending those only which have been observed in the Northern District.

I. PRIMARY.

I. Unstratified.	II. Stratified.	III. Subordinate.
1. Granite;	1. Gneiss;	1. Porphyry;
2. Hypersthene Rock;	2. Hornblende;	2. Trap;
3. Primitive Limestone;	3. Sienite;	3. Magnetic, and
4. Serpentine;	4. Talc, or Steatite.	4. Specular Oxide of Iron.
5. Rensselaerite.		

It is proper to observe, in relation to some of the rocks I have placed in the above Table, that it is not usual to describe them as rocks at all, but rather as minerals; this is the case with rensselaerite, and magnetic and specular oxides of iron. In consideration of their occurring, however, in extensive masses and beds as well as veins, they appear to be well entitled to the appellation of rocks, and I have therefore placed them in the list. Another curious and interesting fact will appear from an examination of the preceding list, viz. that mica and talcose slate rocks, which are so constantly the associates of gneiss and hornblende, are totally wanting in this district. In the Primary districts of New-England, they form the principal rocks. There are, also, other differences between the two districts, the principal ones are to be found in the granites and limestones, and especially in the remarkable developement of the mass which I have termed *hypersthene rock*. Those differences will form subjects of remark when the rocks are under consideration.

1. Granite.

Remarkable as the assertion may appear, still, I believe it to be true, that the granite of the Northern District is not only a rock of small extent, but is also one of the least importance; for, so far as observation may be relied upon, it is very rarely connected with mineral deposites, or associated with any degree of regularity with the metallic compounds.

The granite of the Second District is found in limited patches, forming the surface rock in areas which it is impossible to define or bound; it is quite irregular in its appearance, and is so uncertain in its continuance at the surface, that I shall not attempt to define its extent, except in a few instances. I propose to give merely the principal localities, inasmuch as the area and the extent, so far as it has been traced, can rarely be determined with any degree of precision.

I shall commence the topographical account of granite at Fowler, St. Lawrence county; giving the most important localities on the St. Lawrence side of the district, when I shall close by those upon the Champlain side. Near Halesborough, in the town of Fowler, is one of the largest beds of granite in the county; it extends to Little York; it is about six miles long, and presents nothing worthy of notice, being the usual variety. It contains imperfect crystals of garnet and schorl. At Halesborough, it embraces a mass of coarse white limestone,

which crosses the Oswegatchie a few rods to the west, or northwest of the village, and spreads out extensively into the adjacent fields. At the bridge over the river at this place, the granite partakes of the character of sienite; and in and beneath it, near the water's edge, is a continuation probably of this bed of limestone. It is an important locality for studying the relations of the two rocks; setting at rest, as an impartial observer would expect, the question of the origin of limestone.

At Gouverneur there are several beds of granite; one of which is about two miles on the road to Fowler, and is a fine variety of *graphic granite*. Another is about one mile south of the village, at the locality of phosphate of lime; it is a coarse granite, and is traversed by veins of limestone. It appears to extend south to the village of Antwerp. At some places in this small range of primary, it is difficult to determine what rock predominates, the granite or limestone.

The granite at Gouverneur contains albite, and it appears to be of that variety which is sometimes called *albitic granite*.* It contains, also, large crystals of feldspar, usually at the junction of the two rocks. Pyroxene, scapolite, hornblende and phosphate of lime are abundant, and frequently so crowded as to injure materially the perfection of their forms. The crystals at this place are imperfect and rough also, from another cause; and to account satisfactorily for it, we are obliged to go back to that state when they were in the process of forming. Thus, it is not unfrequent to find crystals of pyroxene enclosing a multitude of smaller crystals of hornblende. The entire form is that of pyroxene, or the form of that mineral is predominant; but on inspecting these crystals, however, we find as much of their surfaces composed of hornblende as of pyroxene, the former standing out slightly in relief, or sufficiently so as to disclose two of the sides of the prism. If the pyroxene were removed by a corroding substance, its form would still remain, but the material would be that of hornblende. The materials, therefore, mutually penetrate each other, but the crystals pass for pyroxene. It is certainly a curious kind of *isomorphism*, and well worthy of remembrance; and it may serve to explain some of the discordant results in the analyses of minerals, or to put chemists on their guard in the selection of subjects for chemical examination.

Another bed of granite appears at Alexandria Bay, and extends down to Hammond Landing. It is a mixture of the grey and flesh-colored varieties. In the neighborhood of the bay, small veins of the magnetic oxide of iron occur in it. At Hammond Landing the bed is quite narrow, and is immediately succeeded by the Potsdam sandstone, which may be seen almost in contact with it. At the landing, there is not sufficient space for any other mass to be interposed between the two rocks, and the precise line of junction is concealed by earth.

Granite appears, also, in the south part of Canton, at Potsdam village, and at Parrishville. At neither of these places does it present any thing worthy of notice. At Malone, between three and four miles west of the village, there is another district of granite. It is in this place traversed by veins of magnetic iron ore, which have been explored. An unimportant vein of

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* Albite in small hemitropes occurs in the cavities of the granite; they are similar in form and appearance to those which are found in the magnesian limestone at Williamstown in Massachusetts.

the same ore occurs in this rock in the south part of Dickinson, not far from the road leading to Duane.

In the town of Saranac, there is a reddish granite, which is extensive and important, if the localities at which it appears are connected masses. Thus, it forms the gangue of the Skinner ore bed, seven miles from Cadyville, and three north of Saranac ; and it is probable that it is the same as that which appears twelve miles west of Plattsburgh, on the military road, where it is remarkably traversed by dykes of greenstone.

Again, beds of this rock occur at Athol and Johnsburgh. At the foot of Crane's mountain, it is the decomposing variety, or that which forms the porcelain clay. Disintegration appears to go on rapidly, and large masses of it may be easily broken into fine pieces.

The localities I have now given, do not probably embrace all in the Second District ; but they are the most important. In pursuing the beds I have mentioned, I have often found them to assume the character of gneiss, and again the gneiss also as often transformed into granite : and thus it happens that it is impossible to say which designation the mass should receive. This fact goes far towards establishing the doctrine that the distinction usually made between granite and gneiss is not one of primary importance, especially in this district.

I have had occasion already to allude to the association of granite and limestone, and I have attempted to separate this variety, (the one associated with granite and other primary rocks,) by the name of *primitive limestone*. The occurrence of these two rocks in the same region, gives origin to several varieties of rocks. It is my intention to notice only one in this place ; the others will be described in my account of this limestone in another place.

I have in view a mass composed principally of feldspar and a magnesian limestone, containing merely a few lamina of mica. The color of this rock is light grey, on a recent fracture ; but brownish, or yellowish brown, when it has been exposed to the weather. It has all the appearance of a granite, and is quite subject to decomposition. It appears, therefore, in a crumbling condition, in broken masses, or ledges. Where it borders a lake, it forms precipitous, broken and unsafe banks, in which there are numerous large cavities. This variety occurs at Muscolunge lake, where it contains fluor spar, carbonate of strontian, and pyritous copper. At "the Bow" in Gouverneur, it is quite an extensive mass, furnishing also pyritous copper. There is another locality of this rock about four miles from Gouverneur towards Fowler, on the Oswegatchie. At this place it is somewhat cavernous, and also contains crystals of carbonate of lime, sulphate of barytes, and the same ore of copper.

I have not considered it necessary to determine with precision the extent of this rock, as it gradually passes into the ordinary granite, or into limestone, and is not at all regular in its course or direction. When cliffs composed of these materials are exposed to some depth, the quantity of calcareous matter in the lower part is greater than above, in a few instances ; but the materials are usually well blended or mixed in most places where it occurs.

This rock appears to be metalliferous. Sulphate of copper, with sulphuret of iron, in nests and strings, is the most constant. After much search and examination, however, I believe this rock will not prove valuable as a metal-bearing rock. The quantity is small ; rarely more than one hundred pounds of copper ore has ever been obtained at one place. Besides this,

the quantity of pure pyritous copper varies in the same mass, the latter frequently changing into pyritous iron.

The origin of this rock, I apprehend, is precisely the same as that of all the granitic compounds. It is not, as some perhaps would be ready to suggest, produced by the overflowing of a moulten mass of granite on a sedimentary limestone, thereby decomposing it; and by which, portions the most intensely acted upon would be raised in a vaporous state, and made to penetrate the mass of cooling granite above. Geologists, in speaking of limestone, seem to be averse to the admission that it may form a portion of the interior of the earth, or even to admit that it may exist there at all; but there seems not a particle of sound reason against the doctrine that it may be as common in the earth as silex, or any of the simple or compound rocks. There is, in fact, more reason to make this inference; for many of the phenomena of nature speak of its being, and proclaim its existence. From what I have seen of it, I am disposed to consider it as one of the igneous products, having its origin in a mode corresponding to all the unstratified rocks, and differing from them merely in the materials of which it is composed. The calcareous matter disintegrates more rapidly than the feldspar; and hence it is common to meet with this rock presenting a spongy appearance, or full of small uneven cavities. These cavities are frequently green, from a slight stain of carbonate of copper, which has also been formed from the sulphuret by decomposition.

The granite of the northern division of the State occupies almost exclusively the lower portions of the primary districts, and it never forms the mountainous ranges. It is confined to the valleys, particularly that variety which is associated in St. Lawrence county with limestone. In Essex and Clinton counties, the granitic ranges are more elevated; but still this rock is confined to the hills or mountains of moderate height.

The agricultural characters of the granitic districts are apparently uninfluenced by this rock. The soil is never derived from it in a proportion which can affect at all its products either for good or bad. The variety which is composed of so large a quantity of carbonate of lime, decomposes rapidly, and forms, so far as it goes, an excellent material for cultivation.

View from Clear Pond, looking towards the northeast, from a sketch by R. C. Taylor.

2. Hypersthene Rock.

Composition and varieties. — Imbedded minerals. — Topographical details. — Effects of frosts, rains, &c. — Scenery.

The rock which I have denominated *Hypersthene Rock*, is essentially composed of labradorite, or Labrador feldspar and hypersthene in very unequal proportions, the former constituting by far the largest part of the mass. Like other primary rocks, however, its constitution is not fixed; the materials not only varying in proportions, but also in kind, particularly as it regards the presence of one of the elements. Thus, the hypersthene may disappear, and be replaced by hornblende or pyroxene, or other changes equally important may take place, without affecting essentially the character of the rock. The labradorite, however, is always present in the mass which has received this designation; and it is this specific mineral which really gives character to the rock, though the contrary appears from the use of the term *hypersthene*. This discrepancy arises from following the usages and customs which are

observed among scientific men, of adhering to that name which has priority; *hypersthene rock*, being the name applied to the same mass in Scotland by McCulloch, previous to its discovery in New-York.

This rock is very intimately related to granite; though its composition is quite different, yet its general aspect is much the same, being unstratified, and traversed by divisional planes in a manner corresponding to the several varieties of the rock. It is, however, darker, especially on a recent fracture; but when it has been exposed to the weather on the sides of mountains, it appears at a distance like the common grey granite, its light color being due exclusively to the influence of atmospheric agents.

The predominant color of this rock is a smoke grey, either light or dark. The color most constantly associated with this is a dingy green, which belongs to the labradorite, and not to the other minerals which happen to be present.

The pieces of rock obtained near the surface are traversed by natural joints, which also belong to the labradorite; they appear in lines of a much lighter color, but more or less broad, in consequence of which it is often checked or spotted. When masses affected in this way are polished, they appear mottled.

By exposure to the atmosphere, the rock becomes light, or ash grey; its surface is often friable from decomposition, and in this respect it is much like the ordinary granite. Especially does this change or action of the atmospheric agents take place on the exposed summits of the mountains, where large blocks crumble down rapidly, and their debris is carried to the valleys by rains and torrents. It even appears quite probable that those large blocks at the summit of Adirondack mountain are nearly *in situ*, having been as it were quarried out by the effective agency of water, air and frosts. However this may be, it is evident that decomposition is far more rapid and powerful in those elevated regions than upon the plains. In the course of time, therefore, no inconsiderable change may occur in the height of a mountain; the contour or shape of the summit may appear much the same, while its actual elevation is slowly but constantly diminishing.

Hypersthene rock may be described under the following varieties, though I would here remark that I attach very little importance to them, as they can rarely be made out without a close and careful inspection:

1. The most common of the varieties is composed wholly of labradorite, though to the eye it appears like a mixed or compound mass, as it has the aspect of being made up of two distinct minerals.
2. Labradorite and hornblende: the hornblende appears usually to take the place of the hypersthene, though not always; for sometimes the latter is still present.
3. Labradorite, hornblende and epidote; the latter, however, never is in sufficient quantity to give character to the rock.
4. Granular labradorite and mica, a variety which is quite dark, and has much the aspect of trap.

Of the varieties which have been designated, the first, as I have stated, is composed entirely of labradorite. It appears, however, in the rock like two distinct minerals, in consequence of the different states the labradorite is in. Thus, in one state, it is crystallized in particles or masses of sufficient size to admit of cleavage, and even sometimes the size of a peck measure, but more frequently varying from the size of a pea to a walnut. The other form

is either compact, or finely granular; so that it presents the aspect of porphyry, or a porphyrytic granite. The proportions of the two forms, or states of the labradorite vary infinitely in proportion: in some instances, the crystallized predominates; in others, the granular or compact. We find, too, in this variety the same diversity as it respects color: the granular is sometimes of a greenish grey, or pure smoke grey, or an iron grey; or, when it predominates in the mass, it is greenish grey; but when the crystallized, it is some shade of smoke grey.

This variety, in any state, is a beautiful rock, even with its rough fractured surfaces; when polished, its beauty is greatly increased. If cut into thin tables, and polished, it would form one of the most ornamental articles for parlors which can be imagined, especially those which are opalescent. Nothing of the kind has yet been in market; and the expense for quarrying, sawing and polishing the material, cannot be determined without experiment. The rock is less hard than quartz. Its powder might be employed in sawing, as in marble. I have hoped that some one would be induced to ascertain the cost of cutting and polishing this rock, for the purpose of introducing it to the notice of the wealthy as a fine substitute for marble, which, being much softer, becomes defaced by use.

This variety furnishes the fine specimens of that mineral which is called *opalescent feldspar*, of which I have noticed among them five kinds of opalescence; the green, blue, both light and deep, golden yellow, the bronze, and that in which the green and blue are arranged in stripes. The deep blue varieties are the most common; in fact, large masses exhibit this striking kind, if placed in the proper position for observing it.

The variety which gives the green opalescence is comparatively rare. It appears, from the specimens of this same rock brought from Labrador, that there the green is the most common, or the golden yellow, both of which are met with in the shops of lapidaries, while the blue is uncommon. In the most perfect specimen, the green and blue may be seen on the same piece by looking in opposite directions: in one, it will be found that the light is blue; and in the opposite, green. It is not uncommon to meet with pieces which are truly gems, and which are not only valuable for their beauty, but of higher value than other gems, in consequence of their being inimitable by any process of art.

The localities which furnish the opalescent feldspar, are principally the beds and banks of the streams and rivers which flow from the Adirondacks, especially the beautiful and extended beaches of the East river, which furnish abundance of very fine specimens. A locality, at which large cleavage pieces of the deep blue variety may be obtained, is Avalanche lake, near the foot of the great slide from Mount McMartin. It occurs here in large, clean masses, from which may be obtained good primary forms of the mineral species. A fact worthy of a passing notice is, that although labradorite is so constantly crystalline, and furnishes such an abundance in this State, it has never as yet been observed in crystals with natural faces—a fact which applies mostly to this substance. Those minerals, for instance, which occur in a crystalline state, appear also (with perhaps a few exceptions) in crystals with natural planes.

Labradorite and Hornblende.—This variety is not uncommon: it is produced by the substitution of hornblende for hypersthene. When this takes place, the principal change is indicated by a darker color of the rock; but it is often difficult to detect the change. The horn-

blende is always in small masses; and besides, the resemblance between the two minerals is so great, that it always requires a careful inspection in order to distinguish them from each other. This variety is generally spotted, the hornblende being collected into little clusters of crystalline masses of a dark grey, which, appearing upon a lighter ground, gives it this aspect. Small grains of garnet are common in this variety; they are often obscure, and hence require the assistance of a microscope to detect them. Garnet has not as yet been seen in crystals much larger than a pigeon shot, and these are imperfect.

Labradorite, Hornblende and Epidote, are also of frequent occurrence; the latter generally appears as a coating, which penetrates into the natural joints of the labradorite. It is known by its peculiar yellowish green colour. It is not in sufficient quantity to give character to the rock.

Granular Labradorite and Mica, is a more common variety than the preceding; the mass is quite dark, and it has more of a trappean appearance than any of the preceding varieties. The mica occurs in small tufted radiating masses, and almost perfectly black. It has, too, much of the spotted appearance of the hornblendic variety—a variety more abundant near the junction of the hypersthene rock with gneiss.

Quartz, which is so abundant and constant in other primary rocks, is extremely rare in this. Where it occurs, it is in seams, or thin irregular veins; indicating, as it would seem, that it does not form a constituent part of this rock.

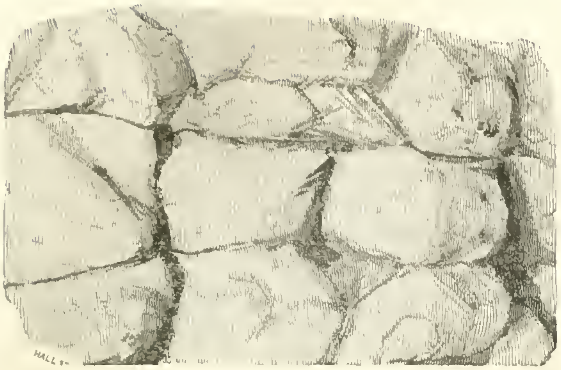
Magnetic oxide of iron is very generally diffused through the rock; it appears in black grains with a resinous lustre, and may be distinguished from the other dark colored minerals by the magnet. Both garnet and iron are most abundant in the rock in the neighborhood of the beds or veins of iron. In some instances, their presence seems to indicate proximity to masses of iron.

Jointed Structure.

Hypersthene rock is traversed by a double system of joints, in consequence of which it breaks into angular masses or forms. Those joints, or divisional seams, run S. 5° W. and N. 85° E. I have found a variation in this direction, amounting to from 5° to 10°, when observed at different places. Near the summit of mountains, thick beds or lamina of the rock separate from the mass in a direction almost parallel to the slope or face of the mountain; appearing precisely like stratification, and might be taken for it, did we not know that the rock is unstratified, and that such an arrangement would not be in accordance to the usual course of the layers composing a stratified mass.

By the operation of various causes in these high regions, blocks became detached entirely from the main rock, and are finally perfectly insulated like ordinary boulders, and appear as if they had been brought from a distance, and left on the perfectly bare rock on which they rest; and this might perhaps be the theory which some geologists would propose to account for their insulated position; but being precisely similar to the mass on which they rest, it is more rational to consider them weather-detached masses which in ancient times once composed a part of the very rock on which they now repose.

2.



The separation of the rock by the natural joints into blocks, often gives the rock a peculiar aspect. The annexed figure will serve to give an idea, both of those joints, and the effects of weathering. The appearance produced is not uniform ; the surface of the rock is frequently checked without much regularity. It is also veined, or traversed by veins of segregation, which are merely harder portions of the same materials which compose the rock ; and for this reason they resist the action of the weather, and hence appear in relief upon the face of the rock. They thus appear like true veins, and give the face of the rock a chequered appearance. Besides the veins of segregation, and the seams marking the course of the natural joints, cracks appear without regularity, which serve to divide the rock into wedge-form pieces, and which in fact are finally broken out, and are strewed around the base of the cliff. In this respect, the rock has a strong resemblance to greenstone trap, or rather sienite, excepting that the latter is a stratified rock.

The rocks which are associated with the one under consideration, are those allied to trap, of which the most constant in its occurrence is a compound of hornblende and feldspar, forming a granular mass quite friable in its texture, and of a dirty grey color. It is generally found in layers in the veins of iron ore, or in the vicinity of ore beds ; it often forms, also, dykes traversing the rock in the manner of the common greenstone trap. An instance of this may be seen at Avalanche lake, where an enormous dyke cuts through Mount McMartin. A deep and almost impassable gorge, formed by the breaking up of this mass, extends to the summit of the mountain.

Two or three varieties of porphyry have been noticed also in this rock. In one of these varieties, the base or ground is a light green compact feldspar, spotted with small masses of a deep bluish green feldspar. It forms quite a handsome rock, and would polish extremely well. It has, however, too much of a mottled appearance ; the small masses being rather too indeterminate, or not in sufficiently distinct crystals to constitute a true porphyry. Another kind is white and reddish white ; it appears like a mass of breccia. The ground is a compact feldspar, either white or flesh-red, in which there are angular masses of greenish compact feldspar. Connected with the two last rocks is prehnite, in mammillary masses of a pale green color, with a few indistinct crystals. It is one of the rare instances of the occurrence of an earthy mineral in the primary rocks, belonging to the family of the zeolites, or kouphone spars. It is found on the East river, about three miles from the settlement at Adirondack. Indistinct seams of prehnite are, however, not uncommon ; but they are so imperfect that they will generally escape attention. A locality in the town of Keene furnished a few fine specimens ;

it was associated in this place with fine crystals of quartz. A very fine specimen of chalcedony was found, a few years since, in connection with a trap dyke. On being cut and polished, it was found to be a very superior stone; it is in the possession of Mr. Henderson.

The porphyries or breccias, which have been found mostly in loose masses upon the beaches of the East river, are undoubtedly all of them in veins like the ordinary trap of this region. One locality is known on this river, which it crosses one or one and a half miles below the Great falls. It is an extremely tough mass, being composed of chalcedony and feldspar, and a decomposable green substance. It is about two feet wide, and pursues the general course of the dykes of this region.

In addition to the above variety of rocks and minerals, we often find rolled masses of the common flesh-colored feldspar or granite, and sometimes handsome specimens of graphic granite. A variety of feldspar, too, is not unfrequent in veins in the hypersthene, which resembles albite; and it seems to take the place of this mineral, or to hold the same relation to the hypersthene rock, that the common albite does to the coarse granites of New-England. It is in laminated and stellated masses, like the albite of Chesterfield; it is not so distinct, nor so handsome. It occurs near Westport in Essex county, on the road between Westport and Port Henry.

Of the varieties of the labradorite not yet noticed, is one of a dark bottle green color, in crystals, usually associated with many of the ores of Adirondack. They are sometimes two or three inches in length, but I have not yet obtained it with natural faces. It is to be procured only in cleavage forms, presenting broad and slightly striated surfaces. It is more feebly opalescent than the blue variety; in fact, it is doubtful whether this property exists at all, though it exhibits a slight change of lustre and color when placed in different positions as it regards the light.

At the head of one of the branches of the Ausable, this rock passes into a light green and nearly compact feldspar. When wet, it is a pale apple green; but when dry, it is dull, and not remarkable for beauty. It decomposes rapidly; so much so, that the weathered surface is covered by a soft putty like substance: it is probably analogous to the porcelain clays.

Limits of the Hypersthene Rock.

In travelling north through Warren and Essex counties, boulders of this rock first appear on the road side, and in stone fences, near the village of Warrensburgh. They increase on going still farther north, and are particularly abundant in the banks of Schroon river, and diluvial gravel beds. A few miles south of the village of Schroon, the rock appears in place. This may be considered as its southern limit. If a line were drawn on the map about northwest to Newcomb, it would mark its southwestern limits; another line drawn northeast to Trembleau Point on Lake Champlain, would be very nearly on the northwestern range. The rock may be traced on the lake shore to Willsborough; the boundaries will be completed by drawing a line so as to pass through Westport about three miles from the lake, thence to Paradox lake, and the village of Schroon.

Hypersthene rock occupies, therefore, a triangular area, which is confined almost wholly to the county of Essex; in fact, it would not be far from the truth to consider all of this county as composed of this material, excepting a belt a few miles in width along the shore of the lake, which is gneiss and hornblende, and rocks of the Champlain group composing a part of the transition class. The width of those rocks diminishes towards the north. In travelling west from Port Henry to West Moriah, the rock becomes decidedly the hypersthene rock in about nine miles; while from the lake at Westport, we fall upon the rock in three or four miles. The passage from gneiss to hypersthene is marked by gradual changes. I have not been able to find a line which marks, with any degree of distinctness, the place where the gneiss on the one side ends, and hypersthene rock on the other commences. Viewed in the extremes, the two rocks are widely different; as they approach each other, the materials of which each are composed become so incorporated, that it is difficult to determine to which mass the intermediate portion belongs.

The area which is occupied by this rock is the most mountainous district in the State, the highest mountain ranking only second in height to any in the United States.

Distribution of the Boulders of this Rock.—A rock whose locality may be so clearly defined, and whose characters are so distinct, becomes one of the best rocks for observation on the distribution of its boulders. I have, therefore, been careful to search for them, wherever my pursuits have called me since the commencement of the survey. The result of my observations is, that they are distributed in lines nearly south of the present rock in the county of Essex. Thus they are found abundantly in the valley of the Mohawk; at Amsterdam, they are very common; and still farther south, in the county of Orange, boulders of this rock attracted the attention of mineralogists at a very early day, from their containing tolerable specimens of opalescent feldspar. This county appears to be the limit of their distribution in this direction.

Although the lines of distribution appear as stated, yet there are important and interesting exceptions. On Lake Ontario, nearly west of the great hypersthene tract, boulders of hypersthene rock are quite common; also on the St. Lawrence in the vicinity of Ogdensburgh. In relation to this line of boulders, however, it is not possible to determine satisfactorily their origin; and I am disposed to assign them an origin still farther north, rather than to the New-York formation. There is a very good reason for this opinion; it is this, there is no line of boulders by which we can trace them to the region of this rock in Essex county, but they appear to be arranged on the lake and river in a direction north and south; and though we may find a few twenty miles east, they become more rare the nearer we approach the table land of the Racket. Those which are found upon the lake and river, however, cannot be distinguished from those in the valley of the Mohawk; they belong to the same rock: but if they originated in the Essex hypersthene rock, it seems very probable we should be able to trace them back to their source.*

* The diluvial marks upon the hypersthene rock are nearly north and south, and an interesting example of them may be seen in the valley of the Adirondack river; they pass over one of the large beds of magnetic oxide of iron, and were finely exhibited by the recent removal of the soil. This locality is nearly 2000 feet above Lake Champlain.

I should have been able to determine this question with greater certainty, if the country had been cleared of forests. As it is, there are many impediments to the successful determination of the question. Again: If grooves and scratches upon rocks are produced by boulders moved along by water, we have another reason for not attributing their origin to the rock in Essex; for we have never observed marks of this kind in an east and west direction: they preserve a north and south direction with great constancy in the valleys of the St. Lawrence and Champlain. Without pretending, however, to decide the question of the origin of these boulders in St. Lawrence county, I would suggest whether it is not more probable that they have been brought from Labrador, or some other region far to the north.

Clay derived from the Hypersthene Rock.—I have already had occasion to remark, that this rock changes from a dark smoke grey to a much lighter color, by exposure to the weather. Being composed principally of a feldspar, it was not unexpected to find the rock forming, by decomposition and disintegration, a substance usually denominated porcelain clay. This result was realized in the discovery of clay in the valley of the Adirondack above Lake Sandford. It occurs in a small basin or meadow, through which a small creek flows which rises in the adjacent mountain, and which is composed of this rock. The color of this clay is grey; it is highly refractory, but not infusible in a porcelain furnace. When burnt for brick, it becomes a light yellowish-brown; hence it appears to contain but little iron.

This clay, on being moulded and placed in the fire, retains the original form of the mass, and is not liable to fly and crack. It becomes a valuable article in this region, and quite essential in the construction of furnaces, chimneys, and other purposes in a manufacturing establishment.

Recapitulation.—I have been thus particular in describing the hypersthene rock and its principal varieties. This course was called for; inasmuch as it had not been regarded as an American rock, until after the survey of New-York was in progress. It is unquestionably one of the most important primary rocks in the State, whether we take into view its extent, its peculiar features, or its productiveness as an iron-bearing rock; for this reason I will briefly recapitulate some of its most striking characters.

1. The rock is darker colored than the ordinary granites, but weathers to an ash grey.
2. It is more or less crystalline; as much so as the ordinary granites.
3. It is composed essentially of only two substances, labradorite and hypersthene; the latter small in proportion to the former; hornblende often takes its place. Epidote, mica and quartz, so often or constantly present in other granites, are very rare in this.
4. Magnetic oxide of iron is also disseminated very frequently through the mass; also garnet in grains or small masses, scarcely ever in crystals: it is common near the junction of the rock with the ore beds.
5. The rocks associated are sienite, and some obscure kinds of porphyry, which have been found only in rolled masses on the banks of the rivers and streams.
6. The rock has a jointed structure; in addition to which, it is often traversed by segregated veins and cracks or false joints; the latter serving to divide the mass into wedge-form pieces, are finally detached, and form the talus at the base of the cliffs.
7. It is eminently an iron-bearing rock; bearing or embracing some of the largest and most important beds and veins of the magnetic oxide yet discovered in the United States.
8. The district of the hypersthene rock is alpine, the mountains being just upon the limit of perpetual frost.

The Scenery peculiar to the Hypersthene Rock.

3.

View of the Adirondack mountains from Lake Sandford.

The influence of the geological formations upon the scenery of a country, has been observed and remarked by most geologists ; and so constant is this influence, that if the landscape is true to nature, it becomes a tolerable guide in the determination of the rock found beneath the soil. The character of the scenery, however, depends much upon the condition of the rock, without regard to the geological era in which it may have been produced. Thus, the soft shales and slates, of whatever age, being deeply weathered and decomposed, are usually concealed beneath a deep soil, and the tops of the hills are rounded and susceptible of cultivation. Every district, therefore, which is underlaid by such decomposable materials, presents a rolling surface. Again, those districts which are level and widely extended plains, with hillocks of sand and gravel interspersed here and there, are recognized as alluvial or diluvial. On the contrary, those indented ridges and conical peaks, presenting a sharp outline in the distance, are at once known as primitive. When we approach them, their primitive features become still more distinct, by gorges, narrow and winding defiles and steep declivities. Greenstone trap and basalt impart also their peculiar characters to the landscape, by their dark colors and their columnar structure ; appearing, when under those forms, like works of art and design.

The vegetable tribes also give character to scenery; and, as many of those tribes are produced in greater perfection and thrift on particular soils, their influence on scenery may be set down as belonging in part to geological causes. Thus the alluvial soils send up a vigorous growth of the plane tree, with wide spreading branches, and covered with a dense heavy foliage; but the dry and arid plains abound in yellow pine and oaks of a dwarfish stature. The butternut prefers the rich loose limestone soil, and the chesnut the thin meagre soil derived from the talcose slates. Many other facts of a similar bearing have been observed by naturalists, but these are sufficient to show the general influence of the rock formations and of geological phenomena on scenery. The district underlaid by hypersthene rock, forms no exception to the principle here stated.

From what has already been said, it will be inferred that the scenery is that which belongs to a primitive formation; and for an idea of the scenery of the Adirondacks, the reader is referred to the cuts illustrative of this subject, on pages 27 and 35. Seen at a distance, the Adirondack mountains which are composed of this rock, appear in groups of conical peaks, and sharp serrated ridges, often broken and interrupted by deep gorges or passes without any determinate direction, but always sharp in profile when unobscured by clouds or atmospheric haze. Placed in the midst of these groups, on some commanding eminence, the spectator finds himself surrounded by precipitous broken mountains, whose sides are deeply scarred by clefts and fissures, the work of frost acting on the dykes traversing this rock; or, laid bare by slides; or else, covered by thickly matted dwarfish firs and spruce. If placed below, his path is hemmed by cliffs inaccessible to man, or by steep brushy banks made impenetrable by stiff dead branches of spruce and knotty fallen trees; or, if the land is low and swampy, impassable from innumerable dead and dying cedars, some fallen, many standing, but all with interwoven limbs hedging up the way, except by the most circuitous route.

The time and place most favorable for viewing the scenery of this region is at sunset, from some lake; for it is then that the waters are still, and the refraction from the surface gives as perfect a landscape below as above; and it is then that the cliffs and steep sides of the mountains, clothed in the deep green of the north, and the lake shore lined with the spiry pointed cedar, the light waving tamarack, and the pyramidal fir, standing here and there like monuments of the dead, create a landscape unrivalled for its magic and enchantment. It is true, that these features belong in part to latitude and height; yet the steep cliffs, and abrupt mountain sides, and grey conical summits in the distance, are the features due to geological causes; which, being combined with those of latitude and height, create a scene which arrests the attention of the hunter or backwoodsman, as well as the man of cultivated taste and refinement.

It is not, however, by description that the scenery of this region can be made to pass before the eye of the imagination: it must be witnessed; the solitary summits in the distance, the cedars and firs which clothe the rock and the shore, must be seen; the solitude must be felt; or, if it is broken by the scream of the panther, the shrill cry of the northern diver, or the shout of the hunter, the echo from the thousand hills must be heard before all the truth in the scene can be realized. These are elements in the landscape, all of which are felt when there,

but are lost in the words of a description, and unsusceptible of transfer by the pencil of the artist.

The points which may be visited with interest in the region of the Adirondack, are too numerous to be mentioned in this place. A fine distant view is obtained from Harrington's hill near Warrensburgh, and also from Mr. Roosevelt's farm in Johnsburgh. A view of the same kind, but from a different direction, may be obtained from Charlotte in Vermont, or from Burlington. The invalid, or man of leisure, who wishes to enjoy the mountain scenery, may visit Johnson's at Clear pond, in Essex county; and, if disposed, may easily ascend the neighboring hills or mountains, by which the whole group will be brought into view. The finest view in this neighborhood is from Mud pond, about three miles north of Johnson's, in which Nipple-top forms a very bold but unique feature in the scene. There is, however, a better combination of elements of mountain scenery from Whiteface, than from any other elevated position in the nothern region. From this mountain the Adirondacks are south, rising in innumerable peaks. To the west appear also mountains; but the most striking objects in this field are the multitude of lakes, which lighten up the view as far as the eye can discern; on the east, directly beneath, Lake Champlain spreads out a silvery sheet, upon which vessels with their white sails may be distinctly seen.

The highest of this group of mountains is best visited by first going to Adirondack iron-works in the town of Newcomb. From this point, a guide may always be obtained to the summit of Mount Marcy, for a reasonable compensation. From this point, too, the whole region may be explored; and if the route is chosen, Long and Racket lakes may be visited, and an exit from the wilderness effected by passing through the Fulton chain of lakes out to Lewis county, or by the old State road to Lake Pleasant, and thence to Amsterdam in the valley of the Mohawk.

To conclude, I may remark that all the large lakes may be visited with pleasure, if it is pleasure to see nature in her untamed and unsubdued state; or any of the high summits in the Adirondacks, if it affords pleasure to see something of the wideness of the world, and to obtain some faint conception of the agitations which its surface has felt, or the deep heavings it suffered when such billows were raised in its crust, as compose this group of mountains.

3. Primitive Limestone.

The term *primitive limestone* is applied to a coarse crystalline mass, which, as a mineralogical species, is easily recognized; but as a rock, holding a definite place in the primary series, is not as readily distinguished. Mineralogically or chemically considered, it is identical with all the coarse white limestones in any of the group of rocks; and hence, it is impossible to describe it lithologically, with a view of placing before the reader any characters by which he may recognize it with certainty. It may be true, that in general it is coarser, more magnesian, and more subject to decomposition, than other coarse limestones, which it so nearly resembles; to which may be added, that it may be associated with a certain class of minerals, which may be confined to this particular limestone. Thus, it is not improbable that,

under certain circumstances, other limestones of a different age may contain the same minerals. I have reference, of course, to those limestones which have been considered metamorphic, in relation to which I shall have occasion to speak before I have finished what I have to say of this rock.

As the views taken of this rock, and which were given in the report for 1838, remain unchanged, I now propose to place before the reader a full account of the observations and facts which led me in the first place to entertain the opinions and doctrines in the report referred to.

The opinions of geologists in relation to the origin of limestone, have been hitherto unsettled. From the great amount of limestone in the strata which may be inspected, it has been supposed that animals possessed the power of forming it, or of combining its elements. This view or theory seems to be wholly unnecessary; for what reason have we to infer that it is a material less common in the interior of the earth than silex or alumine? And if it is common, it may find its way to the surface by the same means as the materials composing other rocks.

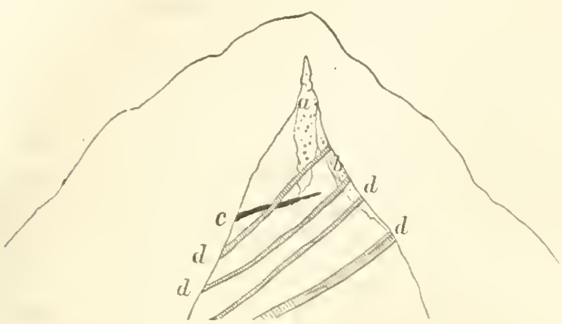
Leaving here the opinions of other geologists, I will state that there are two points which it will be my object to establish: 1st, That it is a rock of igneous origin; and 2d, That it is unstratified, which follows from the establishment of the first point; or if the last proposition is placed first, viz. that the rock is unstratified, its igneous origin seems to follow with equal certainty, so that the points to be proved are really reduced to one; unless, indeed, it can be shown to have been originally a stratified rock, and subsequently, by internal heat, the planes of stratification were destroyed, or in other words, that it is a metamorphic rock.

Before we proceed to the consideration of the phenomena which bear upon the questions proposed, I remark, that in reasoning upon phenomena and facts, we should give them a general construction; that is, if the inferences we draw from them are correct in a given case, or when applied to a certain rock, then we ought also to accept the inferences from the same phenomena and facts, when they are applied to another rock. If, for example, there are certain phenomena in granite, which go to prove its igneous origin, then the same phenomena prove the igneous origin of any other rock in which they may be observed. It is by this mode of procedure that I propose to establish the igneous origin of this limestone; following out the train of reasoning by which Hutton has proved the igneous origin of granite, and the great mass of unstratified rocks. It is applying the same mode of reasoning to a limestone, which has been approved of in the case just cited; and I can see no reason why the principle is not correct and safe: it is one of the modes by which truth is to be finally established.

All the geologists of this country agree in one fact, that a coarse limestone occurs among the primary masses. In the New-England States, this rock is met with very frequently among the strata of gneiss, hornblende, mica, and talcose slates. It is among these rocks that it puts on the appearance of a stratified rock, if any where; and it is here that we are to meet with more difficulties in the determination of the questions under consideration, and where geologists will be more likely to disagree. I shall, therefore, leave the consideration of the limstones in these stratified rocks, and proceed to those found in certain relations with the unstratified, or which are associated with them.

One of the strong arguments in proof of the igneous origin of granite was, that it shoots out into the adjacent rocks in veins, or cuts through them in the form of dyes, like trap. If this doctrine is correct when applied to granite, I can see no reason why it may not be also equally so when applied to limestone.

4.



The annexed diagram is presented as exhibiting phenomena of that kind and character, which I consider will place the two points under discussion in their true light and bearing: *a*, is a mass of coarse limestone, embraced in the hypersthene rock at Long pond in the county of Essex; *b*, a mass of granite; c, a bed of the magnetic oxide of iron; and *d*, *d*, *d*, dykes of greenstone trap. The whole face of the rock has been completely laid bare by a slide, which is thirty or forty rods wide at the foot of the mountain, which is about fifteen hundred feet above the pond or lake. This slide is in the form represented in the cut; and the limestone projects out from the naked rock in the apex of the slide, and is at least sixty feet wide. Its walls or sides are irregular, and unlike the dykes below. The most important fact to be noticed, is, that it comes up from the unstratified rock, and is not an accidental mass resting upon it, but is embraced in it as distinctly as the dykes, the iron ore, or granite.

This mass of limestone is filled with beautiful coccolite, varying in color from white, greenish white, pale green, to deep green, and in fact it appears under every shade and variety of green, all of which have a fine lustre, which, imbedded as they are in white ground, or sometimes a sky blue, forms one of the most showy minerals I have ever seen. Good crystals also of pyroxene occur here, of several modifications; together with large crystals of scapolite, phosphate of lime, and hornblende. A mineral much like idocrase is quite common in small brilliant crystals.

The most important question is, the origin of the limestone. In relation to it, there are but two points, those already placed before the reader: the one, that it is a metamorphic rock, that is, a limestone originally sedimentary, and since changed by the adjacent rock's in a melted state; and the other, that it is an injected mass, analagous in this respect to granite, or a trap dyke, examples of which are furnished at this locality, and exhibited in the diagram.

The first question then is, Is it metamorphic? I should not probably trouble my readers with the discussion of this point; one which is so plain and so decisive, that it appears sufficient to state the case simply as it is, in order to establish the doctrine of igneous injection. But cases as plain and decisive as this, have been supposed by those of high standing as belonging to the metamorphic class.

That I may give fairly a full view of the subject, I shall here quote the opinions of several eminent geologists on phenomena of this character, though not on this particular locality. By

this course, the arguments and opinions, both for and against the interpretation, which I propose, of phenomena of this character, will be in the possession of the reader. I have extracted the following paragraph from Prof. Hitchcock's Geology ;* from which it will be seen what his opinion is, after an examination of the subject. He remarks, "When this rock "occurs in the unstratified class, and also in some of the older stratified ones, it is often *nearly* "or *quite* destitute of stratification. (*Ex. gr.* the limestone beds in the sienite in Newbury "and Stoneham, and in the gneiss at Bolton, Massachusetts; also in hornblende slate in "Smithfield, R. I.; and in granite in St. Lawrence and Essex counties, N. Y.) Hence it "has been proposed to put primary limestone into the unstratified class. (*Prof. Emmons' Re-* "*port on the Geology of the Second District of New-York*, 1838, p. 196.) In many cases, "however, it is most distinctly stratified; as, for instance, in the bed lying between strata of "gneiss on Cole's brook in the west part of Middlefield in Massachusetts. The interesting "examples given by Prof. Emmons, in St. Lawrence county, in his Report† above referred "to, do indeed prove that this rock may exist sometimes in the form of veins in granite. But "looking at all the facts on the subject, they seem more *satisfactorily explained by supposing* "*primary limestone a metamorphic rock, like serpentine, which may be therefore found both* "*stratified and unstratified, than by regarding it as always unstratified and of igneous* "*origin.*"

In relation to the doctrines of this extract I have only two or three remarks to make: 1st, If the limestone of Long pond is metamorphic, I have misunderstood the meaning of the term, if it is not to be confined to those rocks which were originally sedimentary, and whose planes of stratification, subsequent to deposition, have been obliterated by exposure to intense heat. If *this* is the meaning of the word, then the doctrine or explanation is not at all applicable to this particular locality; for I can conceive of no way by which particles of limestone can have been deposited in the mode which here presents itself, to say nothing of the minerals imbedded in the mass. On the contrary, if the word *metamorphic* has any other meaning, I am unable to ascertain what it is, and need make no supposition how it may possibly be employed, or how it may be understood. At Long pond, there is a mass of limestone projecting up from the hypersthene rock for hundreds of feet, which may be traced from below upwards in the face of a mountain whose slope is more than 45°; so much so, that it is extremely hazardous to climb the naked rock. The lines of junction between the two rocks are clearly defined; and hence there is no possibility of a mistake in relation to its position, or its passage upwards from the interior of the mountain. It is not an overlapping or overlying mass; one that was left, or deposited upon the rock.

Again, the remark that serpentine is sometimes a metamorphic rock, remains, as it appears to me, still open for discussion. After having seen most of the serpentine beds in New-England, and those of New-York, I never have yet seen one which is stratified. This rock, wherever it has been seen by myself, was so far removed from the *ordinary* stratified rock,

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* See Prof. HITCHCOCK'S *Geology*, p. 62. Ed. 1840.

† *Report*, 1838, p. 196 to 202, inclusive.

that I conceived it much nearer to an unstratified mass, than to one which is stratified. And then, those instances, in which it is so clearly an unstratified rock, are so numerous, that it appears better to consider the rock as one belonging to the latter class; for at best, the appearances of stratification are very obscure, and not at all satisfactory, being nothing more than what often appears in rocks decidedly igneous, as greenstone, basalt and trap.

It is not to be inferred from the preceding remarks, that the observations of Prof. Hitchcock are undervalued, or may be set aside for slight reasons; for his long experience as an observer places him in the first rank as a geologist, and the cause of difference between us arises from his not having on his part an opportunity for observation in the same field with myself; for I have no doubt but our views of this rock would coincide, if St. Lawrence and Essex counties were made the field for his observations. It appears, however, that other geologists entertain the same ideas of this rock. Thus, Prof. Daubeny appears to entertain the same views of metamorphism in the following passage*: "A blue limestone stratum is said to "overlie the primary or crystalline above mentioned; and this has undergone a very remark-"able conversion, near the line of contact, into a white marble, spangled over with minute "specks of anthracite, just the same has happened to the limestone of New-Jersey." Again, speaking of the geology of Orange county†: "The next remarkable circumstance relative "to the beds, is the conversion of the ordinary blue limestone into white crystalline marble, "when it approaches the gneiss; this limestone contains in all no less than forty-three spe-"cies of minerals."

The first passage cited is a description of a locality which has often been examined under the most favorable circumstances, and with an express reference to the point now under examination; and so far from being an overlying mass, it is one enclosed in hornblende and gneiss, in a mode precisely similar to the limestone at Long pond.

As it regards the latter passage, it is sufficient to remark, that it is the same limestone which is so abundant in St. Lawrence and Essex counties, and which contains also the same minerals in an equal, if not greater abundance. But those masses are never overlying, but are embraced in the primary rocks; and from observations which I was able to make in the county of Orange, several years since, they, too, are never overlying masses, but are enclosed like the limestone of the north; and hence, there is no possibility of conceiving how they can be placed in the class of altered rocks.

Again, Mr. Redfield, in his account of the exploring visits to the sources of the Hudson, has expressed similar views in relation to a mass of limestone at Port Henry. He says, "The remainder of the day, and a part of the fourteenth, were spent in exploring the vicinity, "and examining the interesting sections which are here exhibited of the junction of the pri-"mary rocks with the transition series, near the western borders of the lake; and we noticed "with peculiar interest the effect which appears to have been produced by the former upon

* See *Sketches of the Geology of North America*, by Prof. DAUBENY, p. 28. † *Sketches, &c.* p. 52.

" the transition limestone at the line of contact; the latter being here converted into white
" masses, remarkably crystalline in their structure, and interspersed with scales of plumbago."*

The mass of limestone spoken of by Mr. Redfield, at Port Henry, is another instance of this rock being enclosed in the primary. On one side it is a very pure carbonate of lime, containing small masses of sulphuret of iron, and a yellowish brown mineral resembling some of the varieties of condrodite; but there are no gradual changes in the rock to a blue limestone. On the other side it becomes a variegated limestone, mixed very plentifully with serpentine, asbestus, etc.

I should leave the subject in an imperfect state, were I to omit the opinion of Prof. Henry D. Rodgers, of Philadelphia, who has expressed an opinion entirely on the side of those who support the metamorphic theory; and in his Final Report on the Geology of New-Jersey, he has given in detail his views of the whole subject, which he has illustrated by a remarkable example about four miles southwest from Sparta, at the southeast base of Pimple hill The whole argument is of sufficient interest to be transcribed. " Between three and four " miles southwest from Sparta, on the northwest side of a low ridge of gneiss, we find a very " interesting locality of altered limestone very nearly in the prolongation of the belt which " passes along the southeast base of Pimple hill. This spot is remarkable, less for the extent " or breadth over which the limestone has been affected by igneous action, than for the strik- " ingly convincing evidence which it affords of the nature of the changes induced in a calca- " reous rock by the series of igneous veins and dykes which we have been tracing. The " ridge itself, along the side of which the limestone has been altered, consists chiefly of a " thinly-bedded micaceous gneiss. Through the summit, or rather on the northwestern flank, " which is often abrupt and rugged, there rises a thick *granitic dyke*, a vein of very hetero- " geneous composition, supporting the steeply-dipping beds of gneiss, whose usual inclination " is at an angle of 80° to the southeast. The vein, though various in character, and some- " what difficult to describe, owing to the imperfectly developed nature of its minerals and " their complete interfusion, may be characterized as consisting, in the main, of mica in large " excess, quartz, carbonate of lime, feldspar and augite. It contains spinelle, sapphire and " green talc, besides several other minerals less distinctly crystallized. When we consider " the highly micaceous character of the adjacent gneiss rock, through which the matter of " the vein must have passed in reaching the surface, and the abundance of mica, especially " of the brilliant golden variety, found so plentifully, not only in it, but in the adjacent parts " of the altered limestone, we cannot resist the impression, that a portion of the primary " strata along the sides of the dyke have been melted and incorporated into it, floating, in " combination with the other materials, to the surface. Immediately upon the western side " of this curious vein, and ranging along the base of the hill, occurs the narrow belt of al- " tered limestone. The gradation of change which here exists between the blue and earthy " limestone, and the white crystalline rhombic spar, is distinctly traceable as we approach

* REDFIELD'S *Exploring Visits to the Sources of the Hudson in 1836*, p. 1, 2.

" the igneous dyke. In a breadth not exceeding fifty feet, we discover every degree of modi-
" fication which the rock can undergo by heat. The first intimation which the limestone
" gives us of its having been subjected to igneous agency, is its passage from ordinary earthy
" texture to a sub-crystalline one. We next behold a slight change of color to a lighter tint
" of blue ; and at this stage of the alteration, we notice the first developement of the *graphite*,
" as yet seen only in small but very brilliant scales, which are often times hexagonal. Very
" soon the mass becomes mottled with white, minutely granular carbonate of lime ; the span-
" gles of graphite growing progressively larger. Approaching still nearer to the dykes, the
" whole rock assumes the white sparry character, and contains, near the line of contact, be-
" sides the graphite, several of the numerous crystalline minerals of the vein itself. So com-
" pletely has the injected matter of the vein been mingled, in many places, with the fused
" substance of the limestone, that no distinct line of demarcation is discernable between
" them."*

The above extract contains all that is important in relation to the alteration which the limestones are supposed to have undergone by proximity to the igneous rocks. In relation to the passage, I would remark, that the inferences must be true, if the premises from which they are drawn are correct ; and I should not be so much disposed to question them, if they were confined to the single locality from which Prof. Rodgers has drawn them ; but inasmuch as these veins apply to several ranges of limestone, comprehending numerous bands, and extending in belts from beyond Amity in Orange county in New-York, southwest to Andover forge, the question assumes a different aspect ; for having examined what are termed the altered belts of limestone, at Amity and several other localities in that region, my own conclusions are unfavorable to the metamorphic theory when applied to the limestone in question. It is entirely unessential to state what an observer did not see in this case, for that would be no proof positive that certain facts and phenomena did not exist ; but I did see whole beds of limestone lying between primary rocks, charged with graphite, condrodite, pyroxene, spinelle, etc. all varying much in the perfection of the crystallization.

In relation to the whole matter, so far as the counties of Orange and Sussex are concerned, I am free to confess that my opinions rest partly upon analogy. I find in St. Lawrence, Essex and Jefferson counties, beds of limestone so situated as to preclude wholly the inferences of Professors Rodgers, Hitchcock and others. Mineralogically it is the same limestone ; it contains spinelle, condrodite, pyroxene, graphite, hornblende, mica, scapolite, etc. ; making the analogy between the limestone of the two sections of country complete. Besides, it appears that the reasoning of Prof. Rodgers proves too much. The extent of the influences of this dyke of granite, in the instance which is so well detailed, is greater and more extensive than the nature of the case will warrant. Melted rock, sufficiently fluid to flow, is chilled by contact with other rocks ; the cooled surface then becomes an imperfect conductor of heat ; andthough the mass in the interior remains fluid for a long time, still

* Prof. H. D. RODGERS's *Final Report of the Geology of New-Jersey*, p. 72, 73.

the fluid mass exerts comparatively but little influence on the adjacent rock. That a narrow dyke of granite, even though fused and perfectly liquid, should melt an adjacent mass of limestone far more extensive than itself, is a view which is contrary to analogous facts; and that wide belts of transition or of blue limestone should have been so perfectly melted as to flow, and incorporate itself with other rocks, by a few dykes of granite, seem to be effects too great for the cause assigned. Melted lava is an instance of this kind: the surface cools, and becomes sufficiently firm to support the weight of a man, while the interior is in a melted state. In some instances, so feeble is the effect of injected masses on the adjacent rock, that it is difficult to satisfy ourself that it has been acted upon at all. Remarkable examples of this character are abundant in the vicinity of Montreal, where the Trenton limestone is traversed in all directions by dykes, which must have been melted when injected, as they contain crystals of pyroxene, feldspar and tremolite; yet the effects on the limestone are scarcely perceptible, and not a solitary crystal is produced in the limestone near the line of contact, nor is the limestone in crystalline particles itself.

To account, then, for all the facts and phenomena which primitive limestone exhibits, I find it necessary to adopt other views than those which are contained in the preceding extracts from the published opinion of those eminent geologists whose names appear on these pages, and with whom it is always pleasant to agree; and here I may be permitted to say, that the only theory which meets all the difficulties of the case, is the one I have proposed. Not that limestone never appears as an altered rock; for being a sedimentary rock also, it must be liable to all those agencies to which other sedimentary rocks are exposed. But this by no means alters the question of its original state and condition, any more than it does that of granite, when the sandstones which are derived from it are melted and fused, so as to re-form the rounded pebbles again into a perfect mass of granite. To one who is disposed to doubt in this matter, let him ask himself where all the limestone came from which constitutes so large a proportion of all the rocks of the globe: it is diffused universally. In the primary, transition, secondary and tertiary, it enters largely; there is even an enormous quantity of calcareous matter in the chalk, lias and oolites of the secondary.

There is one point in the Report of Prof. Rodgers, to which I may call the attention of geologists, which bears upon the questions at issue: It is the diversity of dip between what is called, in the Report, the *blue limestone*, and the altered or crystalline mass; with which, in case the latter was a continuous portion of the former, we should expect it would coincide. I will extract the two passages in the report, which contain the statements to which I refer:

" * The narrow valley embraced between those hills and the Wallkill mountain on the " southeast, is in the immediate neighborhood of Sparta, and for some distance southwest, " occupied by the unaltered blue limestone *dipping usually towards the northwest*. Again, " notwithstanding the *prodigious extent* of igneous action to which the limestone has been " evidently exposed in these belts, manifested by the width of the space over which a *total*

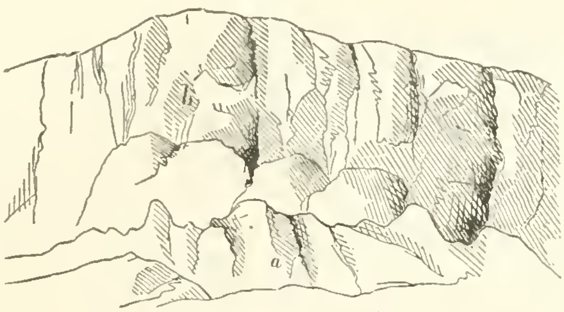
* Prof. RODGERS's *Final Report, N. J.* p. 72 and 76.

" *modification* of the rock has been effected, we discern a *very distinct stratification*, the " beds *dipping steeply towards the southeast*."

Besides the discrepancy in the dip, and for which no cause has been assigned, I am at a loss how to reconcile the *prodigious extent of igneous action*, and the *total modification of the rock*, with the *very distinct stratification* ; for, it would seem, that when there had been a *prodigious* extent of igneous action, and a *total* modification of the rock, the planes of stratification would have disappeared.

I am disposed, after reviewing all the facts which are contained in the above extracts, to maintain that they do not go to support the metamorphic theory, and that it is more agreeable to all the phenomena which have been observed, to place the primitive limestone of St. Lawrence, Essex and Orange counties with the igneous rocks ; but, that I may place this view in a light still more clear, I shall give the following additional facts and illustrations :

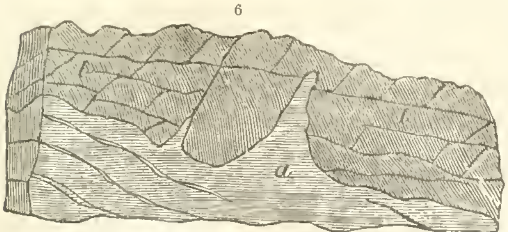
5.



a. Limestone. *b*. Granite.

The annexed diagram shows the position of a mass of coarse crystalline limestone, about one and half miles southwest of Clintonville. It is charged, as usual, with brown tourmalin, imperfect crystals of scapolite, pyroxene, mica, and a few other simple minerals usually included in this rock. It will be observed that it is beneath the granite, which is a mass fifty or sixty feet thick. The limestone rises only about fifteen or twenty feet above the surface of the ground, along which it extends sixty or seventy rods. It is a bold bluff of rock, the upper of which is granite, and the lower limestone.

6



a. Limestone. *b*. Sienitic Granite.

The diagram No. 6 is introduced for the purpose of illustrating relations of a character similar to those in the preceding cut. The limestone is composed of the coarse crystalline particles so common to this rock. The rock which overlies it, is a sienitic granite, traversed by regular joints or divisional seams, which impart to it much the appearance of stratification. This locality is in Fowler, St. Lawrence county, near the village of Halesborough. The Oswegatchie at this place cuts through it in many places, disclosing the relations of these two rocks. The best locality for

observing them is from the bridge near the store. About one hundred rods below, the river cuts through the same rocks again; but the relations are somewhat changed, the limestone appearing here in the form of a dyke as it crosses the river, or rather where the river cuts through it. In the adjacent fields on the west side, it spreads out, and forms the surface rock over a wide area.

This locality is no more remarkable than many others in St. Lawrence and Essex counties; yet it cannot be examined with care and attention, without forcing the observer to the conclusion that the theory of the origin of granite applies equally well to both rocks, and that it would be equally agreeable to facts and phenomena to consider the granite metamorphic as limestone. In truth, if it were necessary to call one of those masses metamorphic, granite in this instance is the one best entitled to that appellation. It is true, that in theory, it might be said that the granite was poured out over a transition limestone, and hence its position beneath the former, and its change from an earthy to a crystalline rock. But this view of the case would be merely theory, without a fact to support or sustain it; it is an hypothesis, or an idea, unsubstantiated by phenomena which appear at either place, and only sustained by the analogy of lava which overflows indiscriminately both ancient and modern rocks.

It may not be irrelevant, while upon this subject, to call in question the metamorphic theory as it is employed for the explanation of phenomena which are peculiar to certain rocks, or so far as it brings in the exclusive agency of igneous action in producing a passage from an earthy state to one which is crystalline. According to modern theory, all the sub-crystalline stratified rock, termed by Boué, crystalline schists, as gneiss, mica slate, hornblende, saccharine limestone, are rocks which have been altered by igneous action; they have passed from the earthy state of the sedimentary rocks, to one which is more or less crystalline. Perhaps it is unnecessary to ask the question, whether this theory, in its length and breadth, is required for the full and complete explanation of the phenomena exhibited by these rocks. If those changes have taken place according to hypothesis, in those instances referred to, is it absolutely essential to bring in igneous action for a rational explanation of the changes which those rocks have undergone? Admitting the original state to have been in the form of earthy deposits, may we not admit the following hypothesis as one entitled to our credence, viz. that the present crystalline state is due to molecular attraction, aided by water of capillarity which bathes every particle composing the rock?

That molecular power is efficient in the production of changes of an analogous kind to a very great extent, seems to be agreeable to observation in many instances. The concretionary limestones, septaria, concretions in clay beds both in the ordinary and the porcellanous clays, crystals of quartz, a laminated structure in rocks, stratification in clay and gravel beds, where the materials have all been thrown together without order, all take place subsequent to deposition, and without the aid of heat. The forces concerned in these changes are feeble; but acting through geological eras, they exert a great amount of force in time. We may conceive that every particle has not only felt the force of attraction, but has actually been moved from its original place. These changes are directly proportional to the fineness of the materials of which the mass is composed; hence the aluminous rocks have the original planes

of deposition obliterated, but new ones often appear, dividing the rock into innumerable rhombic prisms, a form which had no existence in the mass at the time of its deposition. So the sedimentary limestones, being composed of the finest of abraded particles, combine under the form of the species, producing thereby a crystalline mass. The coarse materials of sandstone, however, never assume this crystalline arrangement; and it is only those which are composed of the finest particles, which occur in distinct angular masses, indicative of crystallization on a large scale. Whatever may be the fact in relation to this matter, crystalline masses do occur under circumstances in which igneous action seems not to have been the agent; thus it is with the upper part of the Trenton limestone, which is a grey crystalline mass, and beneath are dull black earthy strata, which being placed beneath, would be more acted upon than those above. This structure does exist, then, without igneous action; and so long as the contrary cannot be proved, we have much reason for believing that the saccharine limestones and crystalline schists may also have been modified by the same cause, without ignition.

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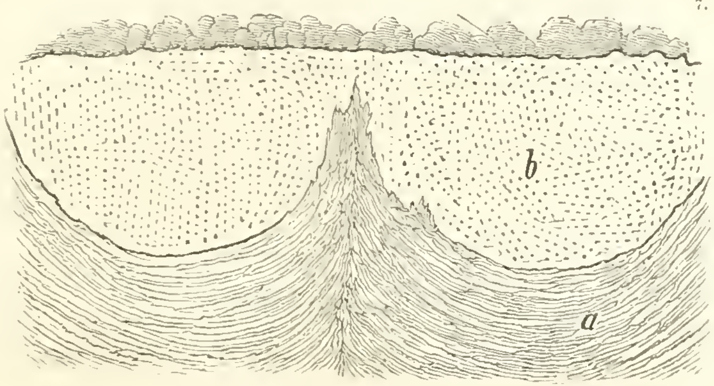


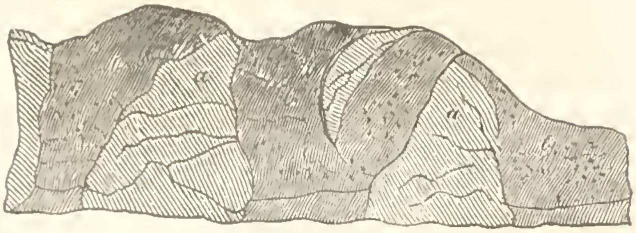
a. Limestone. *b.* Granite.

Returning from this digression, to the subject of the origin of the primitive limestone of St. Lawrence, I refer the reader to diagram No. 7, which, though it shows the same relation of granite and limestone as the preceding cuts, yet presents some features not contained in either of them. The slight wavy surface of the limestone is an arrangement of the materials in a manner resembling gneiss, but still I am not disposed to consider it as stratification: it is an appearance which I am unprepared to explain. The locality is Lyndhurst, in one of the British Provinces.

It will be perceived that the diagrams which I have selected for the illustration of the origin of this variety of limestone, have been taken from a wide extent of country, which fact favors the idea that the relations and phenomena which they illustrate are by no means local. There is a sameness, however, running through the whole of them, and it is probable that it may be thought unnecessary to multiply them to such an extent; and were the question of less importance and interest than it is, such a view of the subject would be just; but as there

are some inferences which will be drawn from the establishment of the doctrine, I have deemed it essential that every variety of illustration should be brought to bear upon the subject.

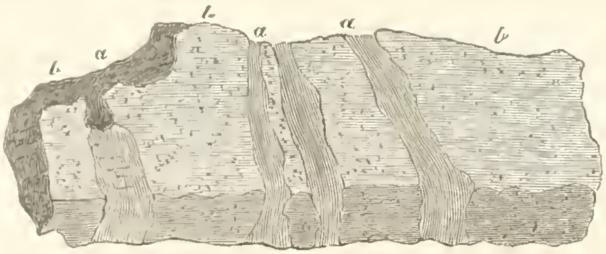
8.



a. Limestone. *b.* Granite.

The wood cut No. 8 exhibits another instance, or example of veins of limestone projecting upwards through a mass of coarse crystalline granite. The veins of limestone widen as they descend. The weathered surface of both rocks is traversed by irregular lines, but totally unlike lines indicating a jointed structure. The limestone is more readily acted upon by atmospheric agents, and hence its surface is below the granite; and it is not only upon the surface that decomposition is going on, but in the interior; and the removal of calcareous matter has proceeded to such an extent as to form quite large cavities, communicating with the exterior.

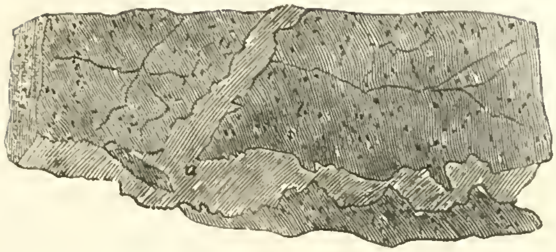
9.



a. Limestone. *b.* Granite.

The annexed diagram No. 9 exhibits four thin veins nearly parallel with each other. Phenomena of the character represented in the cut preclude all suspicion that the granite could ever have been ejected in a melted state, and have flowed over a mass of transition limestone; and were the phenomena reversed, that is, if the granite was the rock beneath, from which veins shot up into the overlying mass, no doubt would have existed as to the theoretical views which it would have supported.

10.

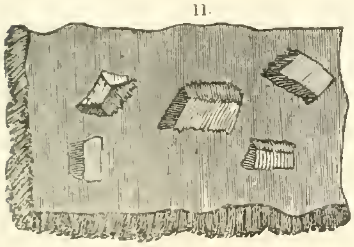


a. Limestone. b. Granite.

Diagram No. 10 differs from the preceding, principally from the connection which exists between the vein and a horizontal mass from which it proceeds. The veins which are disclosed in the rocks, and from which the diagrams are copied, appear in the face of ridges of granite elevated but a few feet above the surface of the ground. They may be traced on the surface very frequently for several rods, or until concealed by soil. They resemble the ramification of granitic veins, and very rarely pursue the straight course of greenstone dykes, being more or less branching into smaller and thinner veins, and finally disappear or run out. In this particular, the veins of limestone and granite resemble each other.

The localities, of which so many have been spoken, furnish a great variety of simple crystallized minerals. They are more perfectly developed at the junction of the two rocks. Scapolite, hornblende, pyroxene and mica, are the most common to those localities. Brucite is not common as in Orange county, and spinelle is still more rare, having never been found at more than two or three places, and at those only in small indifferent crystals, yet in sufficient quantity to show the complete and perfect analogy existing between the northern and southern counties.

11.



The occurrence of foreign matter in the limestone is not at all uniform. In some places, as has already been observed, it is in the form of fine and perfect crystals; in other instances, there is a tendency only to crystallization, or an effort to produce regular forms. In those instances, the masses are strictly mixed or composed of particles of augite, scapolite, and mica, which together form a rude angular mass in the limestone; and which, in consequence of the feeble action of the weather upon them, stand out in relief, as in diagram No. 11.

12.

In diagram No. 12, there is an attempt to illustrate a more diffused condition of the foreign matters. Crystallization appears not to have influenced the form of the foreign matters at all. We find, judging from the appearances produced by weathering, that the separation has taken place by the molecular attraction, or by segregation. Those hard flinty places are readily discovered upon the weathered surfaces of the rock, but scarcely appear where the rock has been recently broken. Both the fine and coarse rocks contain siliceous masses, which are quite injurious, for lime, for marble, or any of the purposes for which limestone is so commonly employed. Although they are not seen without more than ordinary attention, yet it is not difficult to detect them by their hardness. Hence, when this limestone is quarried for making lime, it is necessary to examine the masses, and reject all those which are found hard, strike fire with steel, or are difficult to break ; for all such pieces are incapable of being converted into pure lime.

The phenomena which it has been my object to illustrate, have been thus far drawn from limestone when associated with granite, or with a rock confessedly unstratified. If the subject of its origin were left here, there would remain still the question, whether those appearances which indicate its igneous origin were not due to its association with granite, and whether the non-appearance of planes of stratification is not the effect of the granite upon it ? I have, therefore, examined this rock with great care, wherever I have found it associated with the schistose rocks, as gneiss and hornblende, or sienite.

Most of the following diagrams are selected from those localities where gneiss takes the place of granite ; and it is proper to observe, that all which have been given, have been taken with care and fidelity. It has not been my object to select only those which favored my own views of the origin of this rock. I have, however, this to say, that I have seen none which were equivocal in their meaning, or which at all favored the metamorphic theory.

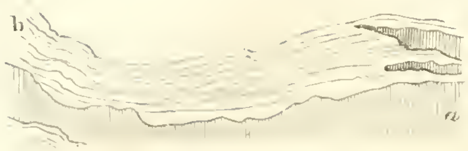
13.

a. Limestone. *b*. Gneiss.

The diagram in the margin shows the position of a mass of limestone in gneiss, near Whitehall in Washington county. It is analogous to what has already been exhibited in the preceding figures, when the same rock is associated with granite.

This may be taken in connection with the succeeding No. 14,

4.

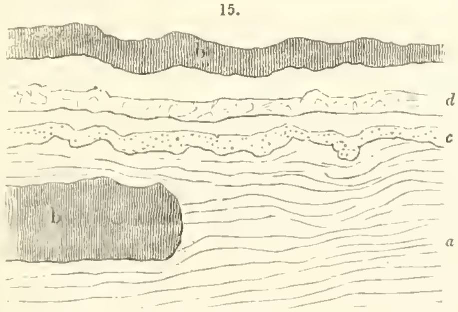


a. Limestone. *b*. Gneiss.

where the limestone has the appearance of having been protruded between the layers of gneiss, which it has disturbed. The limestone is granular, and what is particularly worthy of notice, is its mixture with serpentine ; an association so constant, that there is scarcely an exception in the northern counties. Its presence serves to keep up the analogy between those beds which occur in granite ; while the presence of serpentine, which is an acknowledged igneous rock, goes far in itself to support the theory of the igneous origin of the limestone.

In 13 the limestone not only appears to have protruded upward, and disturbed the beds of gneiss, but also to have produced an important change in the adjacent portion in immediate contact with the limestone. It appears like a band of trappean matter, of a darker color and more compact than the gneiss. It is possible to be deceived as to the cause of this change in the proximity with this mass of limestone ; but that it is some way connected with the influence of this rock, seems highly probable. It is to be observed, that the limestone of this locality is not a pure white crystalline rock : it is brown or grey, mixed in part with quartz and hornblende, and in incoherent masses or grains. It is obscure, and does not form a prominent mass in the rock, and might therefore pass unnoticed, unless the attention was directed to it.

15.



a. Hornblende. *b*. Limestone. *c*. Sienite. *d*. Granite.

The next mass of limestone associated with the schistose rocks, and to which I would direct the attention of geologists, is at Port Henry in Essex county. It is that mass, too, which has already been pronounced upon as one which exhibits evidence of the metamorphic theory. This bed of limestone is extensive, and occurs near the lake ; it projects out of the side hill in a very prominent manner, and forms a conspicuous object from several points of view. There are several points of interest which may be examined with profit in this vicinity ; but I would particularly refer the geologist to this bed of limestone, as one well worthy his examination, occurring as it does in a situation quite accessible, and associated with hornblende, gneiss, etc.

The locality from which this sketch No. 15 was taken, is on the south side of the road, nearly half a mile from the landing, in the field where limestone forms a part of the surface rock. At this locality, the alternating rocks of hornblende, sienite, gneiss, and limestone, are well contrasted; the former exhibiting very clearly what is termed *stratification*, while the limestone is a mass incapable of division in any one direction more than another. The figure is a ground plan, and exhibits one feature worthy of notice: it is the sudden stop which is put to the extension of the limestone in one direction. I leave it to others to offer a *rationale* of such a remarkable feature in the rock at this place.

At this locality, as well as that near the landing, all the phenomena bear favorably upon the igneous origin of limestone. Though in the midst of stratified rocks, it presents no traces of stratification itself, but traverses them in a mode perfectly analogous to granite, trap, or some varieties of greenstone. It furnishes numerous imperfect crystals of pyroxene, mica, and hornblende. The west side of the mass is mixed with green serpentine, passing from light to dark. In some parts it is about equally mixed, the serpentine appearing in masses uniformly about the size of a pea; in others, they are of the size of a peck measure, of pure green color and translucent, forming what is usually called *noble serpentine*. Beautiful asbestus occurs also in seams of a fine silky lustre.

16.

a. Gneiss. *b.* Limestone. *c.* Steatite.

The diagram No. 16 differs somewhat in character from those which have preceded it. The rocks associated with the limestone are still those called *stratified*, as gneiss, steatite, or soapstone. Upon the left is a thick bed of limestone, which is as well exposed as those upon the right; yet I was unable to discover its stratification. It occurs here in a bed, in a mode quite similar to granite, and like a mass which has been projected up subsequent to the formation of those upon the right; of which, were it granite, we should not hesitate to say that it had effected all the disturbance which appears at this locality.*

A very similar arrangement appears at Theresa falls, where the limestone appears in the cliffs composed partly of serpentine, limestone and gneiss; and which, was the stratification at all distinct, would be a fine opportunity for its exhibition if it existed. I conceive this last to be one of those instances in which limestone seems to be *interstratified* with gneiss, a term which appears to be inapplicable where only one of the masses is stratified. It is undoubtedly the case, that in those places where this rock appears to be stratified, the planes are merely an irregular jointed structure. I say, *irregular*; for those planes are never parallel to each other, as a general rule or fact.

* Falls in the Oswegatchie, in Dekalb.

I shall now leave that class of phenomena which I have been so long pursuing; and which, if it is proper so to say, appear to me to furnish conclusive evidence of the proposition early advanced, that limestone, under some circumstances, is an igneous rock.

At my last visit to Theresa falls, in the summer of 1841, while examining the disturbed beds of Potsdam sandstone, I discovered a mass of coarse yellowish crystalline limestone immediately beneath them. On uncovering the lowest layers of sandstone, I found that they were not only vitreous, but were somewhat vesicular. The cavities were angular; and some contained, as it appeared, small masses of limestone: these had disintegrated and fallen out, leaving small irregular spaces. The thickness of the altered portion appeared to be from eight to twelve inches, and might be more, as I was not prepared to uncover the lower portion of the sandstone where those changes were observed. The color of the altered mass is a deep brown, without a vestige of the granular structure which appears in the rock only a few feet above. The line of demarcation between the sandstone and limestone is quite distinct, but is an irregular line similar to the diagram No. 17, where the lower half of the sketch marks the position of the limestone and the irregular line of contact, and the upper, the sandstone.

17.

a. Limestone. *b* Altered sandstone, *c*. Sandstone.

That there is an alteration of this rock, few will question on an examination of the specimens in the State collection, and more especially after an examination of the rock in place. There is, in my opinion, nothing in this case so conclusive as the appearance of the sandstone; it has not passed into the state which is perfectly vitreous, like milky quartz, but is still intermediate between sandstone and that clear vitreous quartz of the common varieties of granite. It is much deeper colored than the common mass of sandstone at this village; and the process to which it has been subjected has given it toughness, and a greater solidity. All these facts, together with its numerous pores, go to show a remarkable change; and inasmuch as the changed portion is in contact with limestone, the inference does not seem to be too far fetched, to attribute those changes to the limestone. Besides, I was unable to discover any other rock at the place, either granite, trap or serpentine, which are usually considered as igneous products. At the village of Dekalb, I discovered masses of limestone in 1837, which also appeared to have been an altered sandstone. Wherever those changes appear in the structure of the sandstone, the rocks have been tilted up; an important fact, when taken in connection with the other facts. They all seem to corroborate each other, and conspire to prove the great fact in relation to the limestone, that it is one of those original constituents of the earth which forms the deeper seated part of the crust, and like granite, has been always

subject to igneous action, which has caused it to protrude in numerous instances among other rocks of a recent date.

There is another fact brought out by the relations of the rock at Theresa falls, besides the one I have just considered: It is this, that the coarse crystalline limestone beneath the sandstone is not the blue limestone described in Prof. Rodgers's Report, from which extracts have been made.* In all localities, that limestone is above the sandstone; and although it should appear that this blue limestone of the New-Jersey Report is truly an altered rock, and that all the facts and phenomena are as stated in the report, yet it does not affect the state and relation of the rock at Theresa; for the position of the mass here is perfectly plain, and no possible change can be conceived by which those relations could ever have differed: the crystalline mass can, by no hypothesis, be placed in the position which this blue limestone occupies. I am sensible that it was scarcely necessary to have presented this view of the subject: the inference is so plain, that few, if any, would probably entertain the idea for a moment, that this mass could possibly be the transition rock referred to; but so common and so popular are those views which represent strata, and even mountains, as overturned, that on every possible occasion they seem to be brought up, and from their astounding character, are fondly entertained, without inquiring whether some other more simple explanation may not be offered, equally satisfactory, and equally agreeable to the facts of the case.

The fact that calcareous spar is the common gangue of metallic veins, is important in the decision of this question. Probably limestone is one of the most constant substances in mineral veins. All the lead and copper mines of St. Lawrence contain abundance of this mineral. I would not assume the point that veins are of igneous origin, though I think there are very few reasons for the contrary opinion; for the electro-magnetic theory is incompetent to satisfy the requirements of these facts. The fact, however, being proved, that limestone is of igneous origin, it goes far towards establishing the filling of veins from below.

Proofs of the igneous origin of limestone, drawn from its imbedded minerals.

Few rocks are so productive in the simple minerals, as primitive limestone. First, we may notice their mode of occurrence, which is probably the fact of the most consequence; thus, they are perfectly disseminated through the mass. Scapolite, pyroxene, hornblende and mica, though they are much more abundant at some particular places than others, still they do not occur in veins; and such is their distribution, and the phenomena accompanying their presence, that no doubt can exist of their being coeval with the rock itself. Their presence, and their condition or relation to the rock itself, differ in no respect from the occurrence of the same minerals in granite. In lava, in greenstone, and especially in that variety of greenstone called amygdaloid, the minerals are evidently posterior in their formation to the rock; filling or occupying the pores and cavities which are formed by the fusion of the materials compos-

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* See Rodgers's *Final Report of New-Jersey*, p. 72, 73.

ing the mass. In general, there is no similarity in the limestone to the latter class of rocks. There are still some phenomena which are inexplicable on any other hypothesis than the one which maintains a previous state of fusion, and which left in some instances oval cavities precisely similar to those so abundant in amygdaloid. These cavities not appearing in the rock itself, but in the simple minerals of the rock, will come up for observation in another place.

I conceive that minerals, when they exist in veins in a rock, or in segregations, are posterior in their formation to the rock itself, and may have been formed in various ways; but they can not be supposed to be connected in any way with the state in which the rock may have been in a time anterior to their production. But when they occur disseminated through the mass, and surrounded on all sides by homogeneous particles of which the rock is formed, and disconnected wholly with cavities, seams or veins, we are necessitated by the facts and conditions of the case to suppose, at the time of their formation, a perfect mobility of the particles composing the rock, and we have two suppositions to make: one, that the mobility of the parts was by aqueous solution, aided perhaps by caloric; and the other, that of igneous fusion, and we are to adopt that view which best comports with our present knowledge of the agents and powers of nature concerned in their production.

Leaving out of view the presence of other minerals in this rock, and of their peculiar relations, I remark, that the occurrence of graphite is the one most decisive in the question under consideration. This view of the subject was taken in the Report for 1838, in the following words: "In relation to the primitive limestone, there is one fact which I deem worthy of notice, and which, it appears to me, has a bearing on the question under discussion: it is the presence of foliated plumbago in all the primitive limestones. At the first thought, it may not appear in point; but when it is compared with the result which always occurs in furnaces when in good action, it certainly becomes important. The fact which I deem the most important, is its production by heat, in those cases where the elements of the material are present; and we have no account of its formation, except in those instances where we have good evidence that igneous action has been concerned. Thus, in no instance do we find it imbedded in sedimentary rocks; but in furnaces, it is produced abundantly when they are in good action, appearing among the cinders and slags at the clearing of the furnace. This substance is made in the greatest quantity when the heat attains its maximum state, but never while it is below a certain temperature."*

In support of the view here taken of the origin of graphite, I have the pleasure of seeing that Prof. Rodgers has recently adopted a similar opinion in his Report of New-Jersey, from which I shall take the liberty of transcribing several passages relating to this subject. "The
" invariable occurrence of the graphite in portions of the altered belt remotest from the dyke,
" and its never existing in more than a trivial quantity even adjacent to the vein, when the other
" extraneous minerals are frequently present in great excess, strongly imply that it has been

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* *New-York Geological Report for the Second District*, 1838, p. 202.

" *derived from the elements of the blue limestone itself,* which may easily be proved to con- " tain an adequate quantity of iron and carbon for the production of this mineral."* And again, p. 73, speaking of the gradation of the changes in this rock, the Report goes on to say : " We next behold a slight change of color to a lighter tint of blue ; and, at this stage of the " alteration, we notice the first developement of the *graphite,* as yet seen only in small but " very brilliant scales, which are oftentimes hexagonal. Very soon the mass becomes mottled " with white, minutely granular carbonate of lime, the spangles of graphite growing progres- " sively larger. Approaching still nearer to the dyke, the whole rock assumes the white " sparry character, and contains, near the line of contact, besides graphite, several of the " numerous crystalline minerals of the vein itself."

The slight difference in the views of Prof. Rodgers and myself, as it regards the question of the origin of the limestone, has no unfavorable bearing upon the question. The Professor maintains the developement of plumbago by igneous action upon a limestone. My views of the limestone differ from his, but not of the causes by which the graphite has been produced. The observation of the graphite in the slags of furnaces, differing in no respect from that of the mineral in rocks, led me to make the suggestion I did in the Report for 1838, that the foliated plumbago might also have been produced in the limestone in a mode very analogous to that observed in furnaces, knowing very well that all who were conversant with chemistry, and with the composition of limestone, would admit its probability.

It would be interesting to examine the composition of graphite as it occurs in rocks, in order to test the question whether there are two compounds of this substance, as it appears there are when it is produced in the artificial way in furnaces. According to the researches of Dr. Charles Schafhaeutl of Munich, there are two kinds or sorts of graphite, which may be produced by running fluid puddling slag, or silicates of iron and manganese, over fragments of pit coal. One is in elastic scales of the thickness of writing paper, with rather a dull metallic appearance ; the other is of the thickness of gold leaf, and extremely unctuous to the touch. The first is a silicate of iron and carburet of silicon ; the other, carburet of iron and carburet of silicon. It farther appears that the formation of graphite commences at temperatures lower than 1500° Fahr., and reaches its highest point not much exceeding 2000°.†

From all the researches which have been made of graphite, it appears to be highly probable that the only method of forming it is by the action of caloric on some substance which contains its elements ; and being a mineral so constantly present in this variety of limestone, its presence of itself makes it exceedingly probable that it has been developed in the rock by igneous action. If so, it is one step towards the solution of the problem concerning the origin of the mass which contains it. This view is entirely independent of the question whether the limestone was originally an igneous product like granite, or is a metamorphic rock according to the opinions of Profs. Rodgers and Hitchcock ; for, by either view, its formation is by the same agency. As yet its occurrence in what have been usually considered saccharine limestones, has not been noticed by me. In this remark, I have reference to those limestones

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* Prof. RODGERS's *Final Report of New-Jersey,* p. 74, 1840. † *Report British Association, in the Athenæum for* 1839, p. 728.

which occur so abundantly in Berkshire county, and which are so generally known as marble, important localities of which exist at Stockbridge, Lanesborough, New-Ashford, Adams, Egremont, and which in fact lie along the whole western face of the Green Mountains.

Notice of some of the peculiar effects which the limestone appears to have produced on some of the minerals imbedded in it.

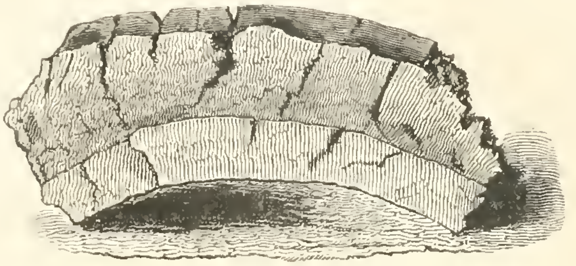
I do not so much propose to make out an argument for establishing the doctrine under consideration, as to present the curious facts of the case. I had, on my first visit to Rossie in 1836, noticed a singular variety of quartz in the limestone which occurs there in abundance, which appeared to have been softened by heat, or partially fused. It is usually in the form common to the species, but imperfect; the solid angles of the crystals being rounded, and sometimes the termination is drawn out like a piece of melted glass, into a sharp point. In other instances, the quartz presents no appearance of crystallization, but it is rounded and frequently wrinkled, as if bent while in a soft or pasty state; in fine, they have all the appearance of silicious slags from a furnace, some much more so than others, but all partake of the character. Sometimes a crystal appears to have been stuck into another while it was soft. The most puzzling circumstance is the apparent fusion of a mass of quartz upon a crystal of feldspar: a rounded mass, though somewhat flattened, appears to be pressed directly upon the feldspar, lying still upon the surface, but in some instances penetrating into a fissure in the crystal. The difficult point for solution, is that the quartz appears to have been softened, while the feldspar, much more fusible, preserves still the sharp corners of the crystal. Admitting the fact of fusion, I see no way to explain the phenomena, but to suppose that feldspar, being more fusible, its particles become perfectly mobile, and recrystallize on cooling; and the quartz being merely softened, does not crystallize, but remains in the condition of a slag. These effects, however, do not stop here: the crystals of phosphate of lime present appearances much the same as quartz, their solid angles being rounded, smooth and vitreous, and many impressions upon their faces being like the impress of some body, as the end of a finger, when soft. In all the crystals from this locality, there are rounded cavities, or else spaces filled with calcareous spar. In no instance are those cavities angular; they appear in this respect like those in amygdaloid, which are often filled with the same substance.

All of these facts are inexplicable, except on the ground assumed, that they have been exposed, while in their beds, to a partial fusion, and at a period too subsequent to their original formation. Whether this is the true explanation or not, it is the only one which I can offer which explains with some degree of probability at least the phenomena in question. Some of the crystals of phosphate of lime are perforated with holes about the size of a pin; these are more angular than the larger. In the centre of a crystal, it is very common to find a large cavity or space in which the continuity of the phosphate of lime is broken, without any communication existing with the outside of the crystal. Sometimes it is filled with a globule of quartz instead of lime; and when those oval masses are removed, they present upon the outside the vitreous lustre.

The minerals which are the most difficult to fuse, are the ones which exhibit this softened aspect; while the feldspar, sphene, scapolite, pyroxene and tourmaline present forms tolerably perfect. Zircon, which is quite common, and is the most perfect, seems to be an exception to this statement; its edges are always finely formed, sharp, and perfect.

Another fact quite common, and equally interesting with the preceding, is found in the fractures and flexures of the crystals. They are finely seen in the long prismatic crystals of zircon and phosphate of lime. The annexed figure is a representation of a bent crystal of phosphate of lime.

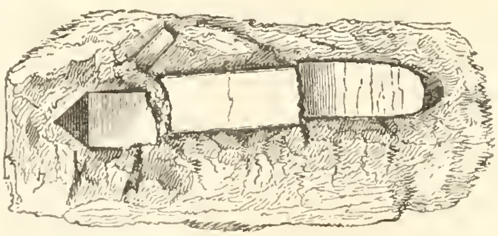
17.



That this substance should be capable of bending, requires a support on all sides, or else that the force should be applied while in a softened state. The surface exposed in the fissures lo k as if they were torn from each other; which favors the state I have supposed the crystal might have been in at the time of its injury. But it is quite common to see the crystals of lime fractured directly, and one portion removed beyond the axis of the other. In fact, very few of the larger crystals of the locality at Rossie, but have been broken, many of which are mended by a thin layer of carbonate of lime. The imperfections of the larger crystals are to be attributed to the fracture they have suffered, and to the numerous imperfections in the interior which I have already noticed.

Most of the large crystals of zircon are either broken or bent. Figure 18 is an example of this kind.

18.



Of the fact of a fracture, there can be no doubt, when we examine the ends or the surfaces of the broken fragments; for we shall find them to fit or match with precision, and might be

mended perfectly after freeing the surfaces from carbonate of lime by a weak acid. The cause of these fractures and bendings must be attributed to movements to which the rock containing them has been exposed. There have been, however, but slight movements in the rock indicated, as it occurs in a low ridge, and is not much elevated. It would seem that movements, though slight, are felt by every particle of matter in the rock; but if it was composed of one homogeneous substance, the fractures of such small crystals would scarcely take place in the mass, as they would be supported equally on all sides; but the rock contains a mixture of quartz, feldspar and other hard materials, and the lime being more yielding than these, allows the particles to move on each other, and hence the fractures or bending observable in the crystals of the rock.

Phenomena apparently similar are sometimes observed in prismatic crystals, particularly in the green tourmaline of Chesterfield, Massachusetts. They have apparently suffered a movement, but it appears to have been by an imperfect crystallization, or an interference at the time the crystal was in the act of forming. It is not then a true fracture, as in the instances of the Rossie phosphate of lime and zircon, and hence the two phenomena should not be confounded together.

Recapitulation of the leading facts on the question of the origin of Primitive Limestone.

1. No instance has fallen under my notice, where this rock appeared divisible into parallel layers like ordinary stratification. The jointed structures, too, are also quite imperfect. The rock is therefore strictly *a mass;* it is a whole, or without regular division seams.

2. Like other unstratified igneous rocks, it appears in the form of veins or dykes, and projects upward through granite and other rocks, in a mode which is inexplicable on any other theory than that of injection from below.

3. It often underlies granite; and is so intimately associated with it, as to greatly favor the idea that its origin is connected and cotemporary with that rock.

4. It has produced, on rocks with which it is in contact, changes which can only be attributed to igneous action; as the obliteration of the granular particles of sandstone, and their reduction to a homogeneous and vitreous condition.

5. Minerals of the same character, and under the same condition, are found in this rock as in granite: thus, mica enters into the composition of primitive limestone, in a mode quite analogous to that observed in granite.

Rocks which may be considered varieties of Primitive Limestone.

1. *Carbonate of Lime and Mica.* A mixture composed of these two minerals, occurs in masses sufficiently extensive to be ranked as a rock. Considering the carbonate of lime as the base of the rock, the mica varies in quantity. It occurs at Antwerp in large masses, some of which are composed almost wholly of mica, the carbonate of lime being only in sufficient quantity to hold the mica together. It is in imperfect columns from half an inch to an inch

and a half high. Other masses, near Muscolunge lake, are composed of about half mica, in small but very perfect crystals in six-sided tables: they are disseminated very equally through the rock. In Chester in Warren county, mica forms a compound rock with carbonate of lime, but is separated more into seams. The color of this mica is an olive green, and the complexion of the rock is very similar to granite.

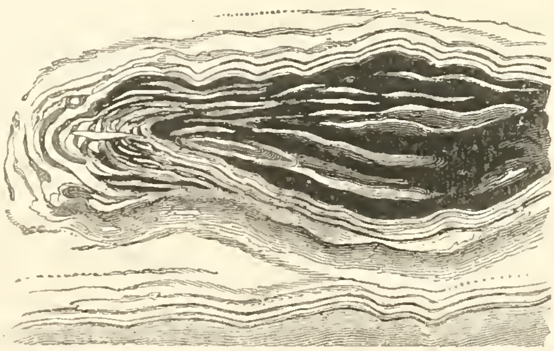
It is scarcely necessary to attempt to describe all the varieties produced by intermixture of these two simple minerals; they are quite numerous; as rocks they are unimportant; but taken in connection with the origin of limestone, these varieties favor very materially the views which have been supported in the preceding pages. We see in those compounds the most perfect analogy preserved between this rock and granite; especially when taken in connection with the fact that the common grey quartz forms a constituent of the rock at many places, though it is not so constant as mica; and perhaps it would have been more agreeable to fact, to have spoken of it under the name of carbonate of lime, mica and quartz.

2. *Carbonate of Lime and Serpentine.* This compound rock is scarcely less important than primitive limestone itself. It will be impossible, however, to speak of the numerous varieties which are common in the northern counties. A few will suffice:

1. We meet with these two minerals combined in the rock in about equal proportions. The limestone is grey or milk white: the serpentine is always some shade of green; pale, or yellowish green, is the most common. Large masses are often seen, compact, translucent, and susceptible of a fine polish.

2. An interesting variety is abundant in Warrensburgh. It contains agatized balls, or oval masses, in which the arrangement of the serpentine and limestone is rudely similar to agate. The annexed cut No. 19 represents this variety. The central portion seems to be a much

19.



harder substance than the serpentine or limestone. By trial, I find it difficult to give a good polish to this variety. Not, however, that it is not susceptible of a fine polish, if treated with care; but where a rock is composed of two or three materials, differing in hardness, the softer wears down more rapidly, and does not appear to be acted upon sufficiently to give the desired lustre.

3. Another very handsome variety occurs in Warrensburgh, on the school lot, and a part of which is owned by Mr. Prosser, who furnished the fine polished slab in the State Museum. The ground is a grey limestone, with large spots of green serpentine; which, being diffused through the mass, gives it rather a mottled or clouded appearance. This is not always the character of the serpentine: in many places the particles of serpentine may be separated from the mass, like grains of coccolite.

Range and Extent of Primitive Limestone.

It is my object, in the next place, to indicate generally the range and extent of this rock; though I am obliged to remark, that I labor under the same difficulties in defining the boundaries of this mass, as in the case of granite: the same difficulties are to be encountered, since the same obscurities exist. This rock occurs so frequently in limited patches or beds, or is concealed by other rocks and soil, that it is impossible to trace out the relations which may exist. In carrying out my plan, I shall proceed, however, on the supposition that the primitive limestone pursues a somewhat direct course or range, and that the beds which lie in given directions from each other are connected beds, though there may be breaks and interruptions by the intervention of other rocks, or concealment from overlying masses of soil and diluvial products. Even though this view may not prove literally correct, still it will assist in description, and give an order to my remarks; and then the localities may, if chosen, be considered as insulated beds, and no error need be committed by following the plan proposed.

I shall commence the description of the range and extent of this rock at Rossie, St. Lawrence county. The first beds worthy of notice, lie in the vicinity of Grass lake. They occur in low parallel ridges in gneiss or granite, and pursue a northerly course.

We may probably regard these beds as forming a part of a belt of limestone which comes up from Jefferson county, and which lies along the eastern margin of the Potsdam sandstone, or that part of the rock which runs along between Hammond and Rossie. This sandstone, on the east of the main settlement of Hammond, is not broken up, so as to disclose the beds of limestone beneath it; but to the east of Rossie. on Grass lake, the sandstone is broken up, and appears in parallel ridges with low grounds intervening, in which it is not uncommon to find ranges of limestone accompanied with granite or gneiss.

If the mass of limestone at Grass lake is a continuation of the rock from Jefferson county, we may assume Theresa falls as its western limit, and consider it as pursuing a northerly course. In following down Indian river, it appears as a very pure coarse limestone in a succession of bluffs, sometimes on one, and then upon the other side of the river. It is every where accompanied by primitive rocks, which bear at one place the characters of gneiss, and at another those of granite. At Muscolunge lake, we find that remarkable mixture of granite and limestone, forming together a mass very subject to disintegration. Following the range of country adjacent to Indian river, numerous beds crop out by the side of the primitive rocks, passing on to the north on both sides of the river, as well as at Grass lake. Tracing this range still farther north, it appears first about half a mile north of the village of Rossie, and

then at numerous places along the eastern shore of Black lake. At Mineral Point, a lead vein is connected with this rock. In a district seven miles north of Rossie, are beds of the same, at the Wilson settlement. This portion of the belt of limestone disappears farther north, under the transition rocks of Lisbon, Madrid and Norfolk. Eight miles to the east of Rossie, in the neighborhood of the Oxbow, there are numerous beds of primitive limestone, bearing in general the same characters and the same relations to other rocks as at Grass lake. They appear in low indistinct ridges, bearing a direction east of north, with granite or gneiss on both sides, but frequently so intermingled together that it is difficult to find distinct lines of demarcation between them. Still farther east, as we travel from Oxbow to Gouverneur, insulated beds often appear. At the latter place, one of the largest of the beds of this rock makes its appearance about three-fourths of a mile south of the village. It may be traced, with few interruptions, south to Antwerp. Following down the Oswegatchie, numerous bluffs arise, and form its banks. This portion of the limestone belt is lost, or passes beneath the transition rocks, in its progress onward, as it meets the southeastern edge of the Potsdam sandstone, near Parishville, Hopkinton and Dickinson.

Another partial belt runs nearly parallel with the preceding, touching the eastern bounds of Antwerp, and extending to Fowler, Edwards, and then into the unsettled parts of the county.

If the section of country I have just described, embraces one belt of limestone only, it may be estimated as bearing an average width of about thirty miles, or from Black lake to Pitcairn or the eastern part of Russell. I am to state, however, that beds of limestone appear at intervals from Black lake to Champlain lake. They are not as common upon the high table land of Racket and Long lakes.

I now pass to the eastern slope of the mountainous region which stretches diagonally across this portion of the State, dividing St. Lawrence from Essex county.

The most important belt of limestone on the eastern slope, commences at Johnsburgh and Athol, and pursues a northeast course along Brant and Paradox lakes, through to Port Henry on Lake Champlain. In some portions of this belt, the rock is highly crystalline, forming the variety usually called calcareous spar; in others, it is merely granular. It is connected with serpentine wherever the mass is large, and with which it is intimately blended, forming by its mixture a beautiful compound rock. Extensive portions of this limestone are thus intermingled at Johnsburgh and Port Henry.

There are only slight differences between this belt of limestone, and that already described as passing through Jefferson and St. Lawrence counties. There are fewer beds of granite with which it is intermingled; and as a whole, it contains fewer of those interesting minerals which are so abundant at Rossie and Gouverneur. Near Port Henry, there are masses of rose quartz, veins of asbestus, green coccolite, blood-red mica, spinelle, etc.

There are still several insulated beds which require a passing notice. On Lake Newcomb, in the western part of the county of Essex, limestone appears, surrounded as usual by gneiss and granite. Most of this mass is impure, being a mixture of coccolite and quartz. Limestone of a very good quality exists at Pendleton; it is very similar to the beds at Port Henry.

In Hamilton county, at Lake Pleasant, there are several beds associated with serpentine;

and at Lake Genet, on the upper waters of Racket lake, there is an important mass forming its western shores. It is important, in consequence of the apparent scarcity of limestone in this region.

In Warren county, in township No. 14, limestone occurs in large beds.

In Essex county, in Minerva and the western part of Chester, this limestone appears to form a belt by itself.

In Duane in Franklin county, large boulders of this rock lie upon the surface, indicating the existence of beds somewhere in the vicinity.

I have not deemed it necessary to describe with minuteness the rock I have found associated with primitive limestone, though I wish it to be understood that all the masses which have been named occur in the midst of a primitive region, passing through it somewhat in the form of belts, though no where perfectly continuous. It forms certainly a very remarkable feature in the region north of the Mohawk valley; and the numerous places at which it appears, furnishes an unfailing supply of this important mineral to the whole region in which the transition limestone is absent. In looking, therefore, over this wide extent of primitive country, we cannot, without violating all the established rules of reasoning in geology, maintain that this rock, which is so abundant, and intruded so frequently between masses of gneiss or granite, can possibly be a metamorphic rock. A sedimentary limestone so situated and so connected, would certainly form a new feature in geological science, and require the establishment of new principles in geological reasoning.

Quality of the lime produced from this rock.

From what has already been said of the compound nature of this rock, it will be inferred that much of it is unfit for burning into lime. There is, however, but little difficulty in obtaining from almost every bed of limestone, that which is of sufficient purity to make the strongest and best of lime. It will require some knowledge of the characters of minerals, in order to be uniformly successful in the selection. One rule may be followod with safety, viz. to select only those masses which may be scratched with a common penknife. Quartz is deceptive, when the eye alone is depended upon; but the distinction between quartz and limestone is readily made, by trying or determining the hardness. Augite and hornblende, being generally colored, will be recognized at once as something quite different from limestone. Scapolite, when massive, will appear to the common observer like quartz, or perhaps no difference will be discovered between it and limestone. The same means may be resorted to in the case of each of those minerals, with success. In examining this rock, therefore, for the purpose of testing its value as a limestone, all that will be necessary will be to ascertain the hardness of the masses which are intended to be burnt, reserving those only which are soft and easily impressed with the knife, and rejecting those which contain hard masses. When pure, it forms lime of the best quality; being stronger, and bearing more sand when used for mortar, than any other kind of limestone.

Character of the Primitive Limestone as a mining rock.

Though few rocks are more productive in simple minerals than this, yet judging from what has resulted from numerous explorations in it, it does not appear to contain large deposits of the useful minerals; and even where veins or beds occur in this rock, there is not so much constancy in the amount of ore, or in the direction it pursues, as in the harder rocks. Wherever, for example, the specular oxide of iron occurs in it, it is in insulated masses; or if it is in a vein, it runs out, both below, and in the direction of the strike; and so completely are all traces of it lost, that it is impossible to determine in what direction it may be pursued in order to recover it. Such is the experience, so far as it goes, in relation to this ore when enclosed in this rock; and I may make the same discouraging remark in relation to the sulphuret of copper, which has been found in it in many places, though not in veins, but in masses which are called by miners *nests, pockets* or *bunches* of ore, which rarely contain more than fifty pounds, and frequently only a mass sufficiently large for a cabinet specimen.

We have not as yet, however, sufficient experience to enable us fully to establish the character of this rock; but so far as it goes, it is unfavorable for extensive and safe mining operations. In this respect, it appears very much like other rocks of igneous origin, in which sublimations of mineral matter have sometimes taken place; or rather, as if the mineral had been enclosed accidentally while in a state of ignition. Speculation, however, is of very little use in the present state of our knowledge; as we are not yet in the possession of a sufficient number of facts to enable us to determine the constancy or inconstancy of the mineral productions which have been observed in this rock. When metalliferous veins come up for description, I shall have occasion to give more in detail the facts which have fallen under my notice.

Simple minerals which have been observed in Primitive Limestone.

The most common are the following:

Mica, of various colors, as olive green, in fine crystallized six-sided tables.

Tourmaline, in brown crystals, frequently fine and perfect, and rarely in small green crystals, in Chester; also yellow crystals, and translucent. Essex county.

Hornblende and scapolite, in good crystals.

Fluor spar; carbonate and sulphate of strontian; the former at Muscolunge lake, the latter in Gouverneur.

Sulphate of barytes; sulphuret of iron and copper; specular oxide of iron.

Quartz, in dodecahedral crystals, in Edwards.

Serpentine; sphene, and phosphate of lime, in Rossie, where it is sometimes red.

Rutile, in Chester.

Fine crystals of feldspar, in Rossie.

Spinelle; rensselaerite; pyroxene, in fine crystals, and very common in the form of grains.

Galena, blende, and pyritous copper; zircon, in fine perfect translucent crystals from one-tenth to two inches in length, at Rossie.

Condrodite, in Schroon.

Graphite is universally disseminated in the rock.

It is a curious fact, that the ores of iron, which are contained in this rock, are in a state of peroxidation. In St. Lawrence county, where this rock is so abundant, the black ores of iron are quite uncommon.

Value of Limestone in Agriculture.

Some experiments have been made with this rock, to test its value as a fertilizing agent, but the results have not been very satisfactory. According to the opinion of some farmers, it exerts a favorable influence; but according to others, it has little or no effect. Such would very probably be the result where but few had tested this question; for it is always to be expected that the circumstances or condition of the ground might determine the result, and which might be unsuccessful in a few instances, and yet, upon the whole, prove a valuable agent in increasing the productiveness of some kinds of soil. It is the opinion of many of the best informed agriculturalists, that lime is quite essential to fertility. If this view is correct, then no reason can be offered why the unburnt limestone should not be useful; for, the state in which it exists in all soils, must be that of a carbonate. A reason why it appears to have no effect, may be its want of fineness, and its slow operation. Marl, which is an argillaceous carbonate of lime, is extremely fine: this is usually esteemed in agriculture, and of its value there can be no doubt. I think, upon the whole, from all the testimony I can collect, that the unburnt limestone will prove valuable in agriculture, if it is reduced to the fineness of the marls, many of which are nearly a pure carbonate of lime. If this conclusion is incorrect, then it will be necessary to give up the prevailing opinion that lime is an essential element in good soils.

Some important inquiries, which follow from the establishment of the igneous origin of Primitive Limestone.

It has been my object to place before the reader all the facts relating to the occurrence of this rock; the precise relation which it holds to other masses; and also to give a general view of its extent, and of the proportion of surface which it bears to other rocks. How it occurs among those rocks, may be seen from the structure of the diagrams which I have used for illustrating this important point; but, it is only by a careful examination in the field, that the student can acquire perfectly correct notions of this rock, and divest himself of the prevalent doctrine, that it is only a sedimentary mass, changed in some places by igneous action. When, however, he sees its position among the schistose, as well as the thick unstratified rocks, he will perceive the insurmountable difficulties to the maintenance of this doctrine; and not till then will the more simple and rational one which I have endeavored to support, be likely to gain his credence. Against this view, I am sensible that there is, if I

may so term it, an *a priori* prejudice ; one which is not likely to yield, until after a full examination of the facts and phenomena which are to be observed in the region where this rock is well developed. The principal hope which I have, therefore, of the general adoption of the foregoing views, is, that geologists will give a full examination of it in the counties of St. Lawrence and Essex, where the rock is so well exhibited in all those relations which I have attempted to describe in the preceding pages.

If the doctrine of the igneous origin of limestone is admitted, several inquiries appear to receive a satisfactory solution. What, for example, can better explain the escape of carbonic acid from the earth in those regions where volcanic action is in operation, than the hypothesis that it is derived from limestone in a state of ignition?* And when the escape is prevented by confinement in cavities, how rational the supposition that it may, by its elasticity, occasion earthquakes, and other analogous phenomena, which are so frequent in volcanic districts. And besides this, may it not be supposed that, under some circumstances, it may be reduced in mass to the state of *calcium ;* a state in which it would become a body quite as energetic in the production of those convulsions, as the disengaged and condensed acid, so justly the terror of all volcanic districts ? And still it appears, that when exposed to heat under sufficient pressure, the whole mass may fuse, without losing its carbonic acid, and in that state be forced upward to the surface of the earth, through fissures and rents in its crust. The doctrine of the existence of metallic bases of potash and soda, long ago taught in the schools of chemistry and geology, has received from many philosophers a ready assent. This state of those alkalies, it is true, is hypothetical ; but how much more probable is the existence of calcium, when so much of the material for furnishing it exists among the primary rocks, and which, from their location and connection, must be associated with them, not only as it regards position, but with their original states and condition, and the action and energetic forces to which they must all be equally exposed.

It is unnecessary, in this place, to refer to the modern improvements in experimental chemistry, in relation to the liquefaction and consolidation of carbonic acid, as striking illustrations of the force and power with which this gas expands, and the tremendous violence which it exerts even in a small way, in order to show what would follow from its condensation in the interior of the earth. These facts are familiar to all who visit the laboratory of the chemist. It is true, we have other agents, as steam, and the gases of various kinds, which must necessarily be developed where intense forces are made to act and react on each other ; but no view of the subject relating to volcanic action and that of earthquakes, so fully recommends itself to the consideration of the geologist, as that which calls in the aid of heat on limestone, followed by the disengagement of carbonic acid, which, under many circumstances, would take place. If no way for escape was opened, and the mass remained under

* "Carbonic acid gas is very plentifully disengaged from springs in almost all countries, but particularly near active and extinct volcanoes. The Grotto del Cane, near Naples, affords an example ; and prodigious quantities are now annually disengaged from every part of the Limagne d' Auvergne, where it appears to have been developed in equal quantity from time immemorial." LYELL's *Principles of Geology*, Vol. I. p. 417.

great pressure, and exposed to intense heat, fusion would be the consequence; but the tendency of the gas to escape under those circumstances must be great: and if, by some cause, passages should be opened into caverns in the earth, there would be an immediate escape of gas with great violence, and which, by pressure on itself, might cause large quantities to liquefy, by which the pressure would increase until some portion of the solid crust of the earth would be found to yield, and give exit to the pent up fluids.

Another view of the subject may be presented, though it is strictly hypothetical, and perhaps there are but few data upon which to found even an hypothesis. It is supposed by many geologists of the present day, that during the early periods of the earth's history, a much greater quantity of carbonic acid existed in a free state than at the present time; and that it was owing to this abundance of the material, so essential to the growth of plants, that we are to attribute the great preponderance of some vegetable forms over those of the present day. Admitting the fact, by what means can we account for such a condition, other than by bringing in the aid of limestone ignited by the more powerful operation of the elements in those early periods, and for the existence of which we find so many indubitable proofs? However visionary these views may appear to others, to myself they are rational; and if admitted, they explain phenomena and facts of ancient dates in a way more clear and full than the ordinary hypotheses of the day. Although it is maintained in one of the most popular geological systems, that the powers of nature are as active and energetic at the present as in ancient periods, still, after a survey of the whole subject, and of the evidence on which those views rest, doubts of their correctness remain in the minds of most geologists. That a more quiescent state should now prevail, and that the former violence of the elements should be restrained, or rather become more feeble by a more equable balance of the forces which act and react on each other, is agreeable to reason, and the benevolence of the Great Architect of the Universe.

4. Serpentine.

Throughout the whole of the northern primitive district, serpentine forms an important member of the unstratified rocks. It is not to be understood, however, that it covers large areas, or forms mountain masses; but that it is of frequent occurrence, holds important relations, and in an economical point of view, is well worthy of consideration.

In giving a detailed account of a formation, or a particular rock, one very interesting view in which it is to be placed, is its resemblance to, or difference from, the rocks of the same species in other sections of the country. By this course, we are able to discover those causes which seemed to have operated in the production of those differences, or to have preserved their similarity; and besides this, we are aided in building up a rational and satisfactory theory of the formation of the earth.

Pursuing our geological investigations in different sections of the country, one fact is brought to light, viz. that rocks of the same name, and very properly considered the same species, do in fact present many remarkable differences. Granite and serpentine, for instance,

do not preserve lithologically a unity of character: the one is a mixed or compound rock, and described as being composed of certain minerals; the other as a homogeneous mass; yet the former is not composed always of the same elements or minerals, nor is the latter always a homogeneous rock. These remarks are made in consequence of having observed a remarkable variation in the characters of serpentine in the Northern District of New-York, from those which belong to Massachusetts and the other New-England States; and I may go farther, and say that some remarkable differences appear in the same rock, though in the same neighborhood, as will be seen in the sequel.

Serpentine is usually green, variegated with spots, deep or pale, and often beautifully mottled. The green is the most common color; still it is sometimes brown, red, yellow, and veined with substances of different colors. So, upon the whole, it presents an unusual combination of characters. It is also one of the most close grained and compact rocks we have. That variety which is associated in New-York with limestone, is usually perfectly compact and translucent; that which occurs in the iron ore beds, approaches to a shaly or shivery mass. Other beds, in other sections of country, as those of Middlefield and Chester in Massachusetts, are finely granular, quite opake, and mostly uniform in color. Varieties with still greater differences are found, some of which are brecciated, as those, for instance, which underlie and penetrate in various ways the beds of peroxide of iron in Jefferson and St. Lawrence counties. This curious and interesting variety contains angular pieces of quartz, from a tenth to half an inch in diameter. Generally they appear closely invested with the serpentine; but sometimes they may be removed, and in fact fall out of their own accord by disintegration. The masses of quartz are angular, and show no appearance of being incorporated with the rock; for this reason, it is quite difficult to offer a satisfactory solution of the question of the origin of this quartzose serpentine.

There has been much discussion of the question of its stratification, and there are able geologists enlisted on both sides. Macculloch and Prof. Hitchcock maintain the doctrine that it is often at least a stratified rock, and Prof. Hitchcock goes so far as to give the dip of the strata; but having often examined the locality in Middlefield, the one referred to by the Professor, I have never been able to satisfy myself of the fact itself.* I am sensible that serpentine is often in splintery or shivery masses, putting on somewhat the appearance of a shaly structure; yet I have not regarded it at all as due to stratification, or even a tendency thereto. The same splintery sharp-edged variety occurs in the ore beds of the north; and often these sharp pieces are striated, as if rubbed against each other, and it appears to be analogous to the glazed slate in the Champlain groups, which I have supposed to have been pressed strongly when in a yielding state, and perhaps elevated at the same instant. So serpentine, after a consolidation at numerous points, might be exposed to pressure; and when forced upwards, the harder masses would slide upon the softer; and by this movement, they would receive those impressions, or stria, which appear on those glossy surfaces termed slickensides, and at the same time give them that splintery sharp-edged condition in which we now find the mass.

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* Hitchcock's *Geological Report of Massachusetts*, Vol. 2. p. 616.

Whatever may be the final determination of the question in relation to the beds in Massachusetts, there can be no doubt relating to the subject in the northern counties of New-York, as no divisional planes can be detected in any of the beds which I have examined. It is therefore an unstratified rock, so far at least as the limits of the second district are concerned.

It will be observed that this rock occurs in three geological relations : 1st, in insulated beds in granite, gneiss, etc. ; 2d, in beds of primitive limestone, with which it is also intermingled ; and 3d, in those of the specular and magnetic oxides of iron.

The consideration of these relations would bring up for discussion the period or age of the serpentines ; whether, like granites, they belong to one or more periods. It is not clear whether we are to regard them as having been ejected at many different periods, or not ; but from analogy, and some few facts and phenomena which have been observed in Massachusetts and northern New-York, the latter view seems to be quite probable. The dislocations at the ore beds, and the change in the sandstone which overlie those beds, are phenomena which very clearly prove some remarkable changes subsequent to the deposition of this sandstone ; and as serpentine is associated with these beds as constantly as trap dykes are with those of magnetic oxide of iron, and as there are no intrusive rocks except the serpentine and specular ore, we have reason to believe that the former had something to do in the production of these derangements, or dislocations. All the proof, however, which exists here, is that the serpentine was protruded after the consolidation of the sandstone ; inasmuch as it is raised up at those places, and is highly charged with the peroxide of iron.

Localities. The most important localities of serpentine are found in Pitcairn, Fowler, Gouverneur, Edwards, Lewis, Moriah, and near Butterfield's lake in Jefferson county. It accompanies all the beds of primitive limestone ; and may be found too at most, if not all, the ore beds in the northern counties. I have already spoken of a curious and interesting variety, the porphyritic or brecciated serpentine, at the sterling ore bed, three miles and a half south of Summerville in St. Lawrence county. I deem it unnecessary to go into a more minute specification of localities in this place, as they will be given in the geology of the different counties.

Near Port Henry, an interesting substance is found, which resembles the primitive limestone. The recent fracture, if made through a thick mass, reveals a surface which is composed in the centre of limestone, serpentine, and a thin stellated mineral somewhat like talc. It appears to be quite homogeneous ; but when decomposed, it leaves a remarkable scoriaceous skeleton, like a mass of porous lava, or tufa. This skeleton is composed of two distinct substances, one of which has the hardness of serpentine, and the mammillated appearance of chalcedony ; the other is soft, in little tufted masses arranged in zigzag lines which intersect each other, and form thereby cavities lined with these small crystals : they appear like talc. It is not remarkable that two or more minerals occur together ; but that the mass of the rock should be composed in the way which is revealed by decomposition, is certainly worthy of notice. Whether the scoriaceous skeleton was first formed, and then its cavities filled with

the calcareous matter ; or whether all the materials were blended together at first, and the arrangement effected by molecular attraction afterwards, are questions not easily solved.

Serpentine, whether pure, or combined with limestone, forms a beautiful and ornamental marble. In either variety, it is mottled, striped or spotted, and rarely homogeneous. One of the finest varieties of the light clouded serpentine is in Pitcairn. A large quantity of the rock has been blasted out, in pursuing a vein of galena. It is, however, far from water carriage, and the heavy expense for transportation would exclude it from market. Another serpentine, still more beautiful, but nearly black, with light colored veins, has been discovered near Butterfield lake in Jefferson county. This is fully equal to the Italian marble, and even with its present disadvantages, its distance from water communication, must force its way into favor. There is a softness and delicacy about it which makes it superior to what is called the *Egyptian marble*.

The greatest difficulty in giving a fine polish to the serpentine marble, is the hardness of the carbonate of lime, which does not wear so fast as the serpentine ; and hence, there remains a dullness of surface, which does not exist where the substance is homogeneous, as in the common marbles ; but by care, and the employment of fine materials for smoothing the surfaces in the first place, a perfect polish may be given.

Origin of Serpentine.

Most writers place serpentine among the unstratified rocks, and my own observations have led me to adopt the same conclusion. By some it has been compared to trap, a rock which is found injected among the other masses in the form of veins or dykes. Although serpentine is clearly an unstratified rock, and in this respect resembles trap, yet, so far as I have observed, it never occurs in injected veins or dykes ; and admitting its igneous origin, it is an interesting fact that it should not sometimes thus occur. It is often intimately blended with limestone, in which it is found often separated in large and small masses ; and when it occurs distinct from this rock, it is in irregular beds of a rounded form, never pursuing a range or strike like a vein or trap dyke, or the layers which compose a stratified rock. It appears, therefore, in great irregular masses, broken into blocks more or less angular, and checked in various ways. It becomes brown, or a dirty yellowish brown by weathering, which affects the rock sometimes to the depth of two or three inches. If an igneous rock, it seems to have been poured out in the state of thick paste, and at a lower temperature than most igneous rocks when projected to the surface. As it does not appear in veins or dykes, so it does not appear to have altered the rocks adjacent to it. It therefore stands by itself in some respects, being very probably an igneous rock. Though not metamorphic, still it is peculiar in the mode of its occurrence ; its peculiarity consisting, as before hinted, in its massive character, in its not occurring in dykes, nor affecting the adjacent strata like ignited moulten rocks.

Serpentine considered as a mining rock.

In this country, few mines have been opened in this rock. In Pitcairn, a thin vein of galena has been opened in it, and pursued some distance ; but it proved a total failure. In Edwards, and in several other places, the specular oxide of iron has been found in it. In both of these cases, however, the rock was a mixture of serpentine and limestone ; and so far as discoveries have been made in the northern counties of New-York, no mineral deposit has been found occupying exclusively the serpentine rock. In Troy in Vermont, however, a mine of the magnetic oxide of iron has been wrought for several years. The ore is in a vein running nearly north and south along the crest of a serpentine ledge for twenty-five or thirty rods. At the working, the vein was ten feet wide at the top. As the work proceeded downwards, the vein decreased in width. Traced to the south along the top of the ledge, it also diminishes in the southern strike, and finally disappears, wedging out in the downward direction as well as in that of its bearing. All the facts and phenomena furnished me at this place, correspond with what I have observed in the mines which have been wrought in the primitive limestone. It is, therefore, a rock which should require more than ordinary appearances, or temptations, in order to induce the expenditure of capital in mines situated in it. A Boston company, in consequence of overlooking the nature of the rock in which this mass of ore is situated, will, in the course of a few years, be obliged to obtain their ore from some other quarter, as the whole of the vein on which the iron works were established will be used up. We see what a difference there is in the constancy of veins in serpentine and gneiss. Thus, at Peru, the veins of the same ore penetrate downwards to the depth of two hundred feet, without any variation of width ; while at Troy, the width has diminished one-third in twelve or fourteen feet. I take the same view of serpentine as limestone or trap, as a rock for mining : it is unsafe, uncertain, and will result, in the end, in the entire loss of the capital invested.

Before I close, however, I ought to make one exception in favor of the working of *chromite of iron.* This mineral, which resembles so strongly the magnetic oxide of iron that it is often mistaken for it, seems to be peculiar to this rock, or rather to belong to it geologically. It occurs in irregular shaped masses, and runs out in a mode similar to the magnetic oxide of iron ; but it may occur in masses of sufficient extent to meet all the demands of commerce ; but, if such large quantities were called for, as of iron ore, to supply a blast furnace, and perhaps several, it would soon be exhausted. It is not, therefore, the great amount of this ore in the rock, which gives safety to working it, but the small quantity required for the purposes to which it is used. It is a remarkable fact, that while the serpentines of Massachusetts furnish chrome ore, those of the northern counties of New-York do not appear to contain a trace of it ; and in this respect, we may perceive another difference in the serpentines of the two regions.

Mineral associates of Serpentine.

Primitive limestone, in northern New-York, is the most constant rock in connection with serpentine. The specular oxide of iron is also one of its common associates. Galena occurs

in a few instances, as at Pitcairn and Fowler. Asbestus, in beautiful silky veins, is abundant at Port Henry. Talc, so commonly connected with the beds of serpentine in Massachusetts, does not occur so frequently in connection with the serpentine of the northern counties. Neither do the minerals of the limestone, as brucite, augite and spinelle, ever occur in the serpentine.

Beautiful satin spar is found in the serpentine at Pitcairn, and copper-colored mica at Gouverneur. The fact, however, most interesting in relation to the serpentine, is of a negative character: that those substances so common, or in fact characteristic in the serpentines of other places, are entirely absent here; a fact which goes far towards confirming the opinion already expressed, that they are of different ages, or belong to different periods. The magnetic oxide of iron does not occur in New-York in the same state of oxidation as at Troy in Vermont, but it is not improbable that the specular ore takes the place of the magnetic; if so, the association of serpentine with the oxide of iron may be considered as a constant fact. The change in the oxidation of the magnetic oxide into the peroxide, is not to be lost sight of; for the only fact of importance is the association of an oxide of iron, its state of oxidation being merely an accidental circumstance.

At Middlefield, Mass., a metallic substance like chromite of iron, is diffused very generally through the rock. Some of the particles are probably the magnetic oxide, and others the chromite. In 1820, dodecahedral crystals of the magnetic oxide in the serpentine were discovered by myself, associated with massive chromite of iron and pseudomorphic crystals of steatite.

5. Rensselaerite.

In placing this substance among the rocks of New-York, I have been governed by the principle, that all masses which exist independent of veins and disseminated particles, or crystals, should be ranked with the rocks proper, though they may be quite limited in extent, and confined, so far as discoveries have been made, to the northern counties of New-York. Rensselaerite, though not strictly a new substance, was separated from steatite, or soapstone, in the report for 1837.* It had been employed under that name for many years, for the manufacture of inkstands, and several other small domestic articles. Their use, however, had been confined mostly to a small section of country; and in consequence of being cut, and imperfectly polished, they appeared much like the common steatite, which was in use for similar purposes. Though there is a resemblance, yet, in fresh quarried specimens, the rensselaerite does not exhibit that flaky appearance so characteristic of steatite; and it required only a slight examination, to discover that it differed materially from soapstone.

Considered as a mineral species, rensselaerite possesses the following properties: Hardness equals 3.5 to 4.0, or between calcareous and fluor spar: specific gravity, 2.874. The crystalline form under which it appears, is an oblique rhombic prism, of the same measure-

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* Appendix to the Report of the Second Geological District, p. 154.

ment as pyroxene. Cleavage, or natural joints, parallel to the terminal planes. The weathered surface is softer than the interior, and is often easily cut with a knife, or scratched with a nail. Color usually grey, with shades of red, green or yellow; but it is sometimes so dark as to appear nearly black, or a very dark brown or green. Structure compact, slightly crystalline, though the individuals are not perfectly developed. It is also in thick fibrous masses, in radiating bundles, like some varieties of anthophyllite or tremolite. Distinct crystals of a reddish hue, occur single in granular carbonate of lime. Fracture uneven: individuals strongly coherent; or, in other words, it is tough. Before the blowpipe, it whitens, and fuses with difficulty into a white enamel; moistened with nitrate of cobalt, it assumes a pale flesh red. It is found in irregular masses and crystals, in calcareous spar, or primitive limestone.

In the report for 1837, I remarked that its crystalline form differs from that of serpentine or talc, and that it is also considerably harder. On account of these characters, it was separated from those minerals. But its crystalline form appeared to be precisely that of pyroxene; and it was impossible, with the common goniometer, to perceive a difference in the measurement of the angles of the crystals belonging to these two substances. It is, however, much softer, and of a less specific gravity; and inasmuch as it has homogeneity and regular structure, it appears proper to keep it separate from that mineral also. It has a close alliance to serpentine, but is harder, and its crystalline form makes it quite distinct from that also. Its name was given in honor of Stephen Van Rensselaer, a distinguished patron of science and learning, whose memory will long be cherished in the community in which he lived. Some mineralogists have supposed that the crystals were *pseudomorphic;* but the fact that they exhibit very clearly natural joints, invalidates this opinion. All pseudomorphics, in their external forms, are perfect; yet they are compact, and destitute of internal structure. As a rock, rensselaerite has a strong resemblance, as has already been remarked, to the soapstone, or serpentine; though it differs in color from the latter, as it never presents those varieties of green; and if green appears, it is an olive green, which I have rarely if ever observed in the serpentines.

So far as I have observed, this rock is not traversed by a system of joints; and the only indications of a jointed structure are numerous irregular seams, disposed without order. It is, therefore, a mass quite amorphous as a whole, occurring in beds like serpentine or steatite.

In consequence of the softness of this material, it is adapted to a variety of purposes. The white varieties are feebly translucent; and when carefully smoothed and polished, after being cut thin, they look very much like porcelain. It is often cut into pipe-bowls, and tea-cups; and were it red, it would resemble the Indian pipe-stone, and it is possible that it is a substance more closely related to that curious rock than serpentine or potstone.

Origin of Rensselaerite.

Being a mass clearly unstratified, and constantly associated with primitive limestone and serpentine, the theory of its origin must be the same as that of those rocks, which has been very fully stated in the preceding pages. It does not occur in the form of dykes, or present a columnar structure like basalt. Its want of stratification, and its association with rocks of whose igneous origin there can be no doubt, are the principal reasons for the opinions I have adopted.

Localities, extent, etc.—The largest mass of this rock is in the town of Fowler, St. Lawrence county, partly on the Belmont farm, and extending south or southwest towards Fowler's lake. It occurs in irregular dark and light-colored masses, which are sometimes traversed by veins of satin spar. Quartz, in thin seams, also cuts through the rock in the neighborhood of the lake. A variety nearly black exists in great abundance on this farm, in which those veins occur, and which, when it is cut and polished, forms a very ornamental rock. I am unable to determine the value of this rock for mantel pieces, or other similar uses ; as in procuring specimens, and breaking them, they appear to be cracked or shattered. When such masses are exposed to heat, thin cracks or flaws, which were not visible, now appear, and mar to a considerable extent its beauty. The stone is very strong and tough, and will bear heavy blows without breaking. Some pieces I have placed in a stove with anthracite coal, where they remained several hours without being injured : it becomes slightly harder, more compact, and loses its transparency, and becomes more susceptible of a polish.

The iron mine in Edwards in the same county, furnishes a handsome white variety of this rock ; it is here associated with serpentine and primitive limestone. Another locality is between Edwards and Russell. Crystallized specimens were found by myself in Canton, in the south part of the town. At Oxbow in Jefferson county, dark radiated masses are abundant, resembling some varieties of anthophyllite.

On the western side of the Oswegatchie in Dekalb, and about twenty rods below the bridge, there is a ridge of white rensselaerite, in appearance much like tremolite. This ridge extends one hundred rods or more down the river, and in a northeast and southwest direction. In many places it is mixed with quartz, like the same rock at Fowler. There is, therefore, a general similarity running through or connected with the different beds of this mineral.

Before I close my remarks upon this rock, I should observe that Dr. Thompson considers the substance described as rensselaerite, to be anthophyllite ; and it is true that some varieties appear externally much like it, still, the crystalline form, which I have been fortunate enough to discover, sets the matter fully at rest.

CHAPTER III.

STRATIFIED ROCKS.

1. Gneiss.

General considerations. — Contains beds of other rocks, as limestone and hornblende. — Limits and extent. — Dip and strike of gneiss. — Mountain ranges composed of gneiss. — Gneiss as a mining rock. — Imbedded minerals, etc.

Leaving for the present the consideration of the unstratified rocks, I proceed to speak of the relations and extent of those which are termed *stratified;* in which group is gneiss, a rock occupying by far a greater surface than all the other stratified rocks in the Northern Division of the State. As its extent and relations will be better understood by tracing it beyond the limits of the Second Geological District, I shall commence at Little-Falls, the most southerly point of that mass of primary rocks which forms the greatest portion of the division to which I have just alluded.

In the first place, it is necessary that I should observe, that gneiss is not continuous throughout the great extent of country whose borders I shall define. It is to be understood, that in addition to granite and limestone, the extent and relations of which have been pointed out, there are frequent interstratifications of hornblende, and a few beds of primitive limestone not yet noticed, as well as other rocks of minor extent. Leaving out of view the hypersthene and the stratified fossiliferous rocks, gneiss is the principal rock, and the one to which all others may be considered in a measure subordinate. Those imbedded masses, as in all the primary rocks, are very indistinctly defined, and not clearly limited; and besides being inconstant and irregular in their boundaries, they are exceedingly difficult to bound with that clearness which is desirable.*

Commencing then as proposed at Little-Falls, the northwestern border of the gneiss may be quite distinctly traced, first in a northerly direction through Norway, Ohio, and the easterly

* In addition to the above, it is proper to add, that in a great portion of the northern counties, the land surveys are so deficient in accuracy, and the landmarks so indifferent, that I had frequently no direct way for locating, with any degree of precision, many localities of rocks, and especially those which are limited to a small area. For this reason, I have omitted to notice many beds of granite and primary limestone, and of hornblende, which I have carefully examined, not discovering any thing important in connection with them. A great portion of the northern primary region appears composed, therefore, of one or two rocks.

part of Remsen; then northwesterly, skirting the western border of the valley of the Black river, through Lyonsdale to Carthage. From Carthage, the rock runs northeast to the Natural bridge; and thence it pursues a northwest course to Rossie, and the upper part of Black lake. Another range of gneiss, however, runs in a direction a little east of north to Pierpoint and Parishville, and then nearly east to Duane, and north through Belmont and the south part of Chateaugay. We have now reached the extreme of the great primary tract; and we here find the Potsdam sandstone wrapped around the northern prolongation of the primary rocks, resting upon them, and concealing them from view. By this arrangement, the primary does not extend into Canada, nor does it approach nearer the provincial line than about ten miles; or, in other words, the northern slope which falls off into Canada, is covered by transition rocks.

Turning now to the southeast from Chateaugay, we find the gneiss to be still the principal rock in the direction of Redford, and then passing to Black brook near Clintonville, where it meets the Ausable, whence it turns nearly due east towards Trembleau Point. Trembleau Point, however, is composed of hypersthene, forming the most northerly extremity of this rock. It therefore breaks the continuity of the gneiss district in this direction; and we may now pass over the termination of the Adirondack group, to Willsborough falls. If a line is drawn from near the falls, through Westport and East Moriah, to Minerva, then northwest to the foot of Long lake, and then again north to Black brook through the waters of the Saranac, it would separate the hypersthene rock from the gneiss. To complete the entire view of the gneiss district, I may add, that Minerva, Schroon, Johnsburgh, Chester, Athol, the country about Lake George, and Luzerne, may be set down as being composed principally of this rock.

By an inspection of the map, and by following the lines traced upon it, it will be seen that a very great proportion of the primary district of the northern counties is gneiss. The rock which ranks next as it regards the area it covers, is hypersthene rock, which has been already noticed, and its boundaries and limits pointed out. It is proper to observe, in this place, that the line which limits the gneiss was represented as passing over to Parishville. There is left out a primary district in this description, lying to the west, viz. that of Alexandria, Antwerp in the county of Jefferson, and Wells's island in the St. Lawrence river. But many of the rocks in these and the adjacent places are of an intermediate character; sometimes a gneiss, passing into granite or hornblende; or granite passing into, or irregularly mixed with, limestone.

In the district which has just been described as gneiss, there are numerous patches of granite, limestone, hornblende, and trap rocks of minor extent. I have, however, considered these as of little consequence, as they do not change the essential features of this area. Thus, at Lake Genet in Hamilton county, there are beds of limestone; also, at Brant lake in Warren county, and in Chester, Johnsburgh, Chesterfield, and in township No. 14. Beds of granite, in addition to those already noticed, are found in Johnsburgh, at the base of Crane's mountain, at Parishville, Malone, Saranac, Clintonville at the Arnold ore bed, and in Dekalb. Hornblende rock occurs one mile west of Westport village, and in Dekalb at or near the Osborn marsh, where it is found in fine crystals as well as in extensive masses.

It will be seen, from the foregoing remarks, that gneiss forms the principal and most im-

portant primary mass in the district north of the Mohawk valley. In some places it is very finely characterized, particularly at Crane's mountain, and the whole range of the Luzerne and French mountains, and in most of Hamilton county. But in St. Lawrence county, gneiss, granite and primary limestone are frequently blended and mixed in such proportions that it is not always easy to designate the mass.

Dip and Strike of the Gneiss.

In a region which has been subjected to so many disturbing agencies as the northern part of New-York, it will be a matter of no surprise to find the inclination of the rocks varying very much in different places. Such is the fact; yet at the same time the strike of the rocks is quite constant, being very nearly in the direction of northwest and northeast throughout the whole district.

By reference to the topography given in the first chapter of this report, it will be seen that a wide belt of highlands traverse the Second District from the southwest to northeast, commencing in the valley of the Mohawk, and terminating upon the west shore of Lake Champlain. Regarding those highlands as an uplift, we shall find that there is a general correspondence of the dip to the several slopes which are thus formed. Thus, upon the east and southeast side or slope, the dip of the gneiss is easterly, or to the southeast; and upon the west, or southwest slope, the dip also corresponds. But this is not true universally, as will be seen from the following statement: At Crown Point landing, the dip is nearly northwest, while at Bulwagga mountain it is east. At Crag Harbor, near Port Henry, it is west; three miles west of Clintonville, it is northwest. Near the landing at Port Henry, the dip is northeast; at the old Crown Point ore bed, it is westerly. At the Hall ore bed in Moriah, it is west; while at the Sandford ore bed it is northwest, and still farther south it is east; but four miles west of East Moriah, it is nearly northeast. On the west side of the ranges of highlands in St. Lawrence county, the dip is not so variable. At Tate's ore bed, the gneiss dips northwest; in Dekalb northwest, and also in the south part of Canton it is northwest. The change in the direction of the dip is quite common, if not general, at the veins of magnetic oxide of iron, which seem to have been connected with the disturbing causes which have so frequently reversed the dip of the strata. The amount of the dip varies also exceedingly; so much so, that in a general account, it is sufficient to say that it is found from 10° to 90°. Thus, at the great falls at Corinth, the gneiss dips only about 10° to the northeast; in a great part of the Luzerne mountains, the dip exceeds 50°; along Bulwagga on the Champlain, it is nearly vertical.

The Mountain Ranges composed of Gneiss.

I had occasion to remark, when speaking of granite, that in the Northern District, it never forms mountain masses, but always occupies the lower parts of the country in which it lies. Gneiss, however, forms some of the highest ranges north of the Mohawk valley, with the

exception of the Adirondacks, some of which are between three and four thousand feet. Crane's mountain, in Warren county, which has been frequently mentioned, is gneiss, except a portion of its base. The whole range of the Black or Tongue mountain, between Lake George and Champlain, is gneiss. So also the range passing through the eastern part of Schroon, of which Pharaoh's mountain is a conspicuous peak, is principally composed of this rock.

It is unnecessary to go into a detail of the ranges, and individual mountains composed of this rock. The general prevalence of it has been already stated ; and we have only to notice the particular exceptions which have been made to it, in the different localities, in order to become acquainted with the formation peculiar to different places in the district.

Gneiss as a mining rock.

Experience seems to favor the opinion sometimes expressed, that the firm harder rocks are more safely explored than the soft shaly ones ; but whether this is true, may not as yet be clearly shown in the present state of mining operations in this country. The fact that veins whose walls are strong and hard give a greater abundance of metallic matter than where they are soft and yielding, is admitted ; and that those parts of the mine which are composed of hard walls contain a larger and wider vein than other portions which are in an opposite condition, is well known to all the experienced miners. Admitting the general facts as here stated, it is not easy to offer a satisfactory reason for this state of things. In the Second District, there are several mines in this rock, some of which have been wrought to the depth of two hundred feet or more. This, it is true, is not to be compared to European mines ; but it is sufficient to give us satisfactory conclusions as it regards the constancy of the mineral matter when in distinct veins. The two principal minerals which have been obtained from this rock, are lead and iron, both of which occur in veins which have been explored to the depth of two hundred feet. Without anticipating what I have to say in relation to these two substances, in the proper place, I have only to remark, that very little change was found in the quality of mineral matter at the depth here stated, from that at the surface : if there was no increase, it is clear that the decrease has been so small that it has not been observed. Even thin and unimportant veins have been pursued for some considerable distance, without finding a diminution of ore.

These remarks apply to those mines which are clearly in gneiss ; for to those which are situated in rocks subordinate to this, as limestone, serpentine, etc. they will not be found to hold good. Neither are they true of those mineral substances which are diffused or disseminated through it ; for those substances which are thus associated are always uncertain in their extent, and in the amount of ore which they furnish. But veins which are distinct and well defined appear to be always well filled in this rock, in the Northern District, and to carry the mineral matter to as great a depth as has yet been explored, without material diminution or the substitution of an inferior one. It is true that different portions of the vein are not equally rich and productive, and are not equally wide ; but many portions become wider by a reces-

sion of the walls, and then narrow again by pinching in, as it is termed, when the vein loses width. I shall have farther occasion to speak of this subject, when I take up for consideration the iron ores, and a few other substances which have been found in veins in this rock; and it is sufficient that I remark in this place, that it is a valuable rock for mining, in consequence of the permanence of the mineral matter, whether it is pursued downwards, or in the direction of the strike of its veins. Besides this, I may state, that it is by no means an unproductive rock, as will be seen in the sequel. It is true, however, that there are quite large tracts which appear to be entirely destitute of metalliferous veins. Such is the case with a large part of Hamilton county, which is composed mostly of gneiss; and there appears to be but few instances in which even stony matter occurs in veins, or, in other words, dykes appear to be less frequent than in Essex, where mineral veins are quite common.

Imbedded Minerals.

Gneiss, in the Northern District, cannot be said to be prolific in simple minerals. Its connection with iron ore, limestone, serpentine, and their particular associates, have been stated in detail. Considered independent of these rocks, it is in truth barren of interesting minerals. Indifferent crystals of tourmaline, garnet, hornblende and pyroxene, are not uncommon; but these minerals do not occur in perfection, except where the gneiss is associated with limestone, quartz or granite. Zircon and phosphate of lime, in small crystals, occur not far from Clintonville. Limonite, or the brown peroxide of iron, and graphite, near Ticonderoga; sulphuret of iron, diffused through the rock in Canton, and in numerous places; one of the oxides of manganese, crystals of quartz, eupyrchroite, epidote and pyroxene, at Crown Point; green fluor spar, and crystals of calcareous spar, at the Arnold ore bed in Peru, constitute the greater part of the simple imbedded minerals in the gneiss of the northern counties of New-York.

2. Hornblende.

There are no extensive masses of this rock in the Second Geological District. It forms ledges from twenty-five to eighty rods in length, in many places, but is not continuous over large areas. Sometimes it forms a compound with gneiss, a mixture in which hornblende takes the place of mica, forming a dark colored rock, which appears much like sienite, excepting that it does not break into tabular masses.

This rock is of so little consequence, that I have merely introduced it for the purpose of saying that it is one of the rocks of this district. At Port Henry, it forms a part of the hill immediately in front of the landing; and is here, as usual, connected with primitive limestone. Some of the beds and veins of the magnetic oxide of iron are in this rock; and so far as it is considered as a mining rock, it is as productive as gneiss. The ores of iron in this rock are more pyritous, and tougher or more difficult to break, than in granite or gneiss. Thus, at Crag Harbor near Port Henry, the ore is extremely difficult to break and prepare

for the furnace. This toughness may not be a constant character with the ores embraced in hornblende.

This rock is associated with many other beds of ore in Moriah. The ores of Duane, in Franklin county, belong also to it. In most of the instances cited, if not all, it is merely a mass subordinate to gneiss. All the details which have been given of gneiss, as it regards strike and inclination of the beds, apply to this rock.

3. Talc, or Steatite.

This substance is readily distinguished by its soapy feel, and its extreme softness, being easily scratched by the finger nail. Its colors are green, greenish white, and silvery white without a tinge of green or any other color. When of this latter color, it is extremely tender and quite lamellar, and soils the fingers like chalk. It lies between the layers of gneiss or hornblende. It is not at all abundant in the Second District.

Localities.—Near the Belmont farm in Fowler, some of the whitest and purest soapstone is found interlaminated with gneiss. On the Oswegatchie in Dekalb, St. Lawrence county, it occurs nearly as white as that at Fowler. Much of the rock called *soapstone* in this vicinity, is *rensselaerite*, which is not so white and pearly, nor so soft as talc. For lining stoves, for jambs, hearths, etc., either rock may be employed.

Soapstone has been employed as a paint, and forms for some purposes an article quite valuable: it is used for giving body, and any color which is desired may be employed with it. It is particularly useful in places where lead and other articles are exposed to the action of acids and other corroding agents. With silex it forms a fusible compound, which may be employed in pottery. But its common use, that of a fire-stone for hearths and furnaces, is one of the most important. Hence it is an object to search for it among the slaty and schistose varieties of gneiss. In conclusion, I would remark that steatite is far less abundant in the formations of New-York, than in those of the Green Mountain ranges of Vermont.

4. Sienite.

The term *sienite* is applied to a stratified rock, composed of feldspar and hornblende. It is always dark-colored, but less so than hornblende rock; it is frequently grey, in which case both the feldspar and hornblende are in a granular state. It frequently differs so little from hornblende, that it is difficult to draw lines of distinction. For this reason, it is rarely necessary to keep up the distinction which it has been usual to make between those rocks. They certainly pass into each other, by the predominance of one or the other of its elements. In the same bed, we may often find every variety which can be formed of these two minerals.

Its relation to other rocks.—Sienite, besides being a constant associate of hornblende, appears very frequently as an injected rock, in the form of dykes, and is intertruded into

the beds and veins of the magnetic oxide of iron. The great dyke which cuts through Mount McMartin in Newcomb, is sienite. It is also of frequent occurrence in the beds or veins of iron at Adirondack, though the rock embracing the ore is hypersthene. It would appear, from these facts, that it is, at least in some instances, to be regarded as of igneous origin. Of its stratification, dip, and value as a mining rock, I might make the same remarks as in the preceding pages, when speaking of gneiss and hornblende.

CHAPTER IV.

SUBORDINATE ROCKS.

1. Trap. Greenstone Trap.

General characters of these rocks; composition, structure, origin, etc.— Trap dykes and mineral veins compared.

The term *trap* has long been used in geology, and has at different times been applied to rocks apparently of different characters and origin. All those rocks in which hornblende forms a constituent part, have been called by the general name of *trap*. The term, as now employed, is more restricted, being confined to rocks which are without doubt igneous, as the stony veins called *dykes*, and the columnar and amorphous masses resembling basalt; for an example of which, I will refer the reader to the rocks called *the Pallisades*, on the west bank of the Hudson river, a few miles above the city of New-York. Other rocks of a similar origin are sometimes called *trap*, in a general mode of speaking, as basalt and amygdaloid: the former being a black, fine-grained, or compact homogeneous rock; the latter, a mass originally full of cavities, like those of lava, most of which have been filled with various crystalline minerals, as lime, prehnite, stilbite, analcime, etc.

The trap of the northern counties of New-York exists only in the form of stony veins, which traverses all the other rocks in a direction varying but a few degrees from an east and west course; the walls of which are generally distinct and parallel, and may be traced for great distances as readily as a road or a highway.

Trap is a compound mass, in which we may usually discern various minerals by the unassisted eye, as hornblende and feldspar in close and intimate admixture: these form the base or ground, in which crystals of hornblende and pyroxene are frequently disseminated. Sometimes the dykes are columnar; that is, there is a division of the mass into short irregular columns, with from four to six imperfect sides disposed at right angles to the strike of the vein, and never in the direction of its length; and also in masses resembling amygdaloid, the cavities of which are sometimes empty, and in others filled with calcareous spar. It is again very compact, like basalt, slightly crystalline, with short needle-form crystals disseminated through the mass.

In general, trap is a dark green when freshly broken; but when it has been exposed to the weather, it is grey or yellowish brown grey. It is a rock easily affected by atmospheric agents, by which its color is not only changed, but it is broken up into angular fragments. It is tough, and breaks with an uneven splintery fracture, except in a few instances where the mass is vitrified, when it is brittle, and breaks with a conchoidal fracture.

Such are the general characters of trap, as it occurs in the Second District. I have observed it, however, under very different circumstances. Thus, some of the dykes which traverse the Trenton limestone at Montreal are white, with beautiful crystals of white tremolite and sulphuret of iron disseminated through them; which, in hand specimens, without knowing the connection and relations of the mineral, would be mistaken for some other substance.

Origin and Composition of Trap.

It is, without question, of igneous origin, and is composed of hornblende, pyroxene and feldspar; in some instances, it is hornblende with feldspar; in others, pyroxene takes the place of hornblende. The white dykes of trap spoken of in the preceding paragraph, are composed of feldspar, with very little if any iron, except what is combined with sulphur, forming crystals of sulphuret of iron disseminated through the dyke.

It is scarcely necessary to go into a statement of the arguments for the origin of this kind of rock. The fact that it bears the marks of fusion in various degrees; the alteration or changes which it produces on other rocks, or the walls of the rock which the dykes traverse, and the difficulty attendant on any other theory, seems to place the question on satisfactory grounds.

Trap dykes compared with mineral veins.

The resemblance between dykes and mineral veins, or those filled with metallic substances, is very close. They resemble each other in pursuing ordinarily a direct course, and in having walls of the rock more or less distinct and well defined. There are slight differences worthy of notice: thus, a mineral vein in general is less regular in the direction, width and perfection of its walls. It often bulges out, sometimes to a great width, and then diminishes, or is *pinched in;* sometimes so much so, as to bring the walls nearly in contact. The greatest difference, however, consists in the diversity of their contents, which is in part expressed in the terms or names given to masses themselves; and it is highly probable that the different phenomena exhibited in the two cases, are to be attributed to this diversity. Those who are conversant with mineral veins of any description, must have observed the great quantity of crystallizable materials, as calcareous spar, fluate of lime, forming what is called the *matrix* of the vein. Now is it not probable that veins filled with materials of this character may be less compacted together, more liable to have vacant spaces, and points which would support the adjacent wall less securely, than the thick stony and less crystallizable matter which compose trap dykes? Hence the liability of the walls of the vein to be less securely sup-

ported; and hence, too, when exposed to lateral pressure, they would fall towards each other, or *pinch in*. I do not propose in this place, however, to enter upon the discussion of the origin of mineral veins; and these remarks are intended only to show the general analogy between dykes and veins, and that even the diversities which they exhibit may be explained without the adoption of two theories for their formation and origin.

For the origin of trap dykes, it is sufficient for our purpose to suppose that, by some cause, cracks and fissures were formed in the rocks subsequent to consolidation, and that they have been filled with a thick paste of moulten matter from below. The facts and phenomena which may be learnt from a study of this kind of rock, will be given more particularly when upon the subject of mineral veins; inasmuch as they are all intimately connected, and require to be taken up or considered together.

2. Porphyry.

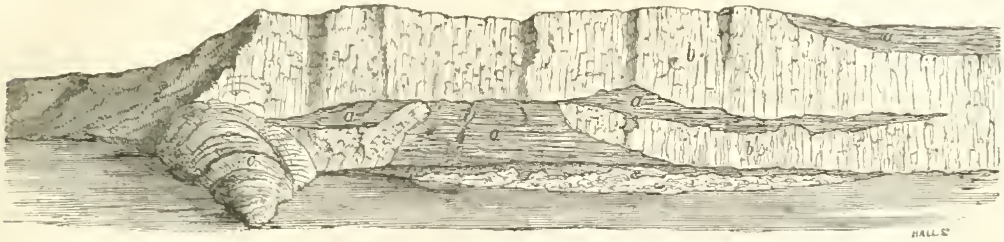
There is but one mass of porphyry in the northern counties, which has fallen under my observation. This one is interesting in three respects: 1st, it is connected with the upper slates of the Champlain group; 2d, it presents a false stratification; and 3d, it has produced no change in the slates which rest in contact. These points will come in for consideration in the subsequent paragraphs.

This rock is composed of a ground of compact feldspar of a reddish color, in which small light-colored crystals of the same substance are sparsely diffused. It is columnar as a whole, being divided in the mass into short imperfect columns arranged perpendicularly. The most interesting locality of this rock is at Cannon's Point, about one and a half miles below the village of Essex in Essex county. It appears as an intertruded rock between the layers of slate, which at some points are disturbed; but in others, there appears very little change in the original disposition of the layers, or in their texture. This structure may be observed at several other places along the shore in the direction of Split Rock.

Another interesting feature which this mass presents, and which I have denominated above, *false stratification*, may be seen at the rise in the road towards the village of Essex. It is here separated into plates or lamina from one-fourth to one inch in diameter; which, being arranged one above the other like the regular strata or layers observable in all regularly stratified rocks, produce this peculiar character; and so perfect is the resemblance, that a hasty inspection, while passing over the locality, would result in the impression that it was truly a stratified rock. In order to correct this view, it would be necessary to observe the disposition and characters of the lamina, when it would be seen that the structure is after all columnar. There is no interposition of fine and coarse particles, or those peculiar appearances which necessarily exist where rocks are formed by the successive deposition of particles, or the formation of thin or thick layers according to the amount of matter in suspension at different times, or of fine and coarse materials according to circumstances, which must always appear in the mass at different periods of its deposition. Besides this, its distinct columnar structure at several places where it is exposed perpendicularly on the lake shore by the breaking up of

the rock by waves, and also its interposition in the slate, makes it very clearly a rock which has been formed at a period subsequent to the consolidation of slate with which it is connected, and not by the successive depositions of particles from suspension in a watery medium. The apparent stratification is interesting in another point of view: it proves the liability of mistaking this structure for a true stratification, in those cases where the means of detecting and correcting the error does not exist; as serpentine, basalt, greenstone, etc., all of which sometimes exhibit divisional planes analogous to those exhibited by the porphyry at Cannon's Point.

20.



a, Slate; *b*, Porphyry; *c*, Disturbed portions.

The wood cut, (fig. 20,) represents the position of the porphyry at Cannon's Point. The disturbed portion is seen on the left, and the regular columnar mass in the middle and upon the right. What is particularly worthy of attention, is the slight alteration and disturbance which has followed from the injection of so large a mass of matter as appears in the slate at this place.

In addition to what is seen of this rock along the shore of the lake, it appears in considerable force in the fields on the west side of the road, where it covers a hundred acres or more, being apparently spread out over the slate and a portion of the Trenton limestone. It is quite broken and fragmentary in many places, presenting low cliffs, in the face of which there are a few rounded concretions. To the south about four miles, at a place known in the neighborhood as *Rattlesnake's den*, it appears in a bluff of from one hundred and fifty to two hundred feet high. At this locality, it presents the same characters as at Cannon's Point; and in consequence of its structure and its exposure, it has been broken into an immense quantity of pieces three or four inches in length and two in diameter, which have fallen down to the shore and formed a steep talus, over which it is extremely difficult to pass, in consequence of the loose state of the fragments which continually slide under the foot.

Nature, Origin and Period of Formation of the Porphyry.

If the porphyry appeared only at the last mentioned place, it would have been impossible to have spoken very definitely of the period when it was formed, as the rocks in which it is inclosed belong to the primary class; but taken in connection with the slate of the Champlain

group, it is clear that it belongs to a period subsequent to the deposition of this group. There being no newer rock in this region than the slate referred to, it is impossible to bring the date of its formation to a later period.

From what has been said of the characters of igneous rocks in the preceding chapters, it will be unnecessary to state here the reasons for adopting the opinion that this mass of porphyry is an igneous injection. The facts which I have had occasion to state, fully confirm this view; and yet there is one which, though it has been alluded to, ought to receive a moment's attention: it is, that though the mass must be considered as igneous in its origin, still it must have been in a state quite different from the ordinary rocks of this class, inasmuch as there is no change produced in the texture, structure, or organic remains of the slate with which it is in immediate contact. Specimens of graptolites, and remains of the Trinucleus tessellatus, were found unchanged, and almost in immediate contact with the porphyry. This fact then seems to favor the conclusion that the mass was in a state of thick paste, and like the matter sometimes ejected from volcanoes in a state of mud, but whose temperature was comparatively low, or not sufficiently high to act on the rocks with which it came in contact.

Varieties, etc.—There are only three or four varieties of this rock: the reddish brown, which is the most common; the pale-leek green; the jaspery, which is a hard compact stone, with a fracture somewhat conchoidal; and the dendritic. The last differs from the ordinary infiltrations, so frequent upon the outside of the layers of rocks: it is exhibited in the interior of the irregular columns. The dendritic matter has penetrated nearly to equal depths on all its sides, forming a beautiful arrangement: it extends to the depth of two or three inches in some pieces; while in others, only to a half or one-fourth of an inch.

To give a rationale of the movement which produced the forms and figures within the stone, it seems probable that the whole rock was immersed at one time in a watery medium, containing manganese or the oxide of iron in solution or suspension, which penetrated not only between the columns, but was forced into the columns themselves by a movement called *endosmose*. Each separate piece has its own figure complete, penetrating into the interior according to the time during which it was immersed in the fluid, or in proportion to the facility with which the stone absorbed the metallic oxide.

This rock, though not important in an economical point of view, is still interesting on account of its relation; and besides, it is so distinct from all other rocks in the vicinity, and confined to a small territory, that its boulders become very good guides for the determination of the direction of the currents of water which have swept over this section of country. In this respect, it compares with those of the hypersthene rock, which may be so readily distinguished from gneiss or granite. I have often seen the porphyry in loose pieces in the soil fifteen or twenty miles south of Cannon's Point, and in a direction nearly south of this locality; and if I may rely upon memory, it is not found far to the east or west of a north and south line.

This mass has evidently been broken up quite extensively; as its fragments, in a rounded state, line the shore for long distances, particularly towards Split Rock, where immense quan-

tities of the worn and rounded fragments cover the shore. It forms a beautiful material for garden and door-yard walks, and ship loads of it might be transported to any part of the lake. The examination of the beach formed of this material, exhibits a curious example of the power of the waves to sort and collect the pebbles ; those, for instance, of a given size, are gathered together, separated and placed by themselves. All the large ones occupy places distinct from the smaller ; and in using them for walks, we have only to select the size we wish for the object in view.

There are no facts connected with the porphyry of Essex, by which its character as a mineral bearing rock is revealed, except, indeed, those of a negative kind : no rock of this character is found in connection with mineral veins or beds, in the northern counties.

In giving the extent of this rock, I have supposed it to have been once a continuous mass, and to have extended from Cannon's Point to Rattlesnake's den, a distance of about five miles. This, however, is a matter of conjecture, and the opinion is founded upon the perfect similarity of the rock at all the intermediate places where it is to be seen.

I would take this occasion to recommend to students in geology, to visit the shores of Lake Champlain. It is a field full of interesting and instructive phenomena ; one in which the dynamics of geology may be studied to the best advantage. Moreover, the field is quite accessible, and every part may be visited at an expense not disproportionate to the advantages which may be obtained.

3. Magnetic Oxide of Iron.

Reasons for placing the oxides of iron among the rocks.— State of oxidation accidental.— Form in which the two oxides occur among the rocks.— Masses and veins.— Appearance of stratification.— Association of garnet with veins of magnetic oxide, etc.

On account of the great extent of the oxides of iron in the northern counties of New-York, I have considered them deserving of a place among the rocks ; and as they resemble, in their mode of occurrence, the trap, greenstone and porphyry, I have arranged them all together. By this course, I do not mean to maintain that the resemblance is complete ; it is, however, sufficiently near to admit of their being placed in juxtaposition. It will be perceived that I have kept the two oxides of iron distinct ; though in this there appears to be no very good reason, for the state of oxidation is to be regarded as an accidental circumstance, rather than one which is fixed and necessary. It is true, undoubtedly, that the magnetic oxide is formed of definite proportions of its elements originally, but it is liable to change, and pass to the state of a peroxide ; to become, in fact, so far as its composition is concerned, the specular oxide ; and it will probably appear, on a careful analysis of the magnetic ores, as they exist in their beds, that some considerable diversity exists as it regards the proportion of oxygen in combination with the iron. Besides this, their mode of occurrence geologically is not very different. The collective facts derived from both oxides as they exist in the earth, when taken together, constitute but one class of phenomena, or bring out and establish but

one class of principles; but still, externally, the two oxides are quite dissimilar, and for a detailed account, seem to require a separate consideration.

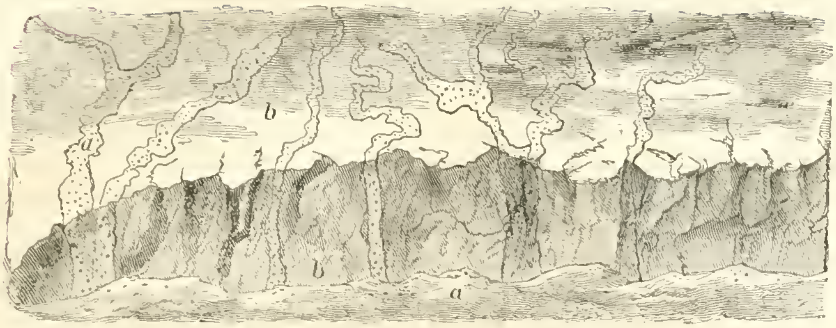
Geological Position.

The magnetic oxide is found in two geological forms: 1st, in that of masses; 2d, in that of veins. In the northern counties, we have numerous examples of both. I would remark here, that I have used the word *mass*, not in its usual meaning, but as expressive of a particular form, or mode in which this ore is found. It is a mineral inclosed in rock, in an irregular manner, so far as its connection is revealed: there are no regular boundaries; it projects into the surrounding rock, and becomes more or less incorporated with the adjacent portions. To see more clearly what is meant by a *mass*, it may be contrasted with a *vein*, which is a space of a certain width and direction, filled with mineral matter, but with boundaries clearly defined by what are termed *walls*, which are formed of the fractured rock itself, and upon the whole are considered parallel, though at many different places the parallelism does not exist. The word *mass* may be confined to the form of occurrence, as defined above; reserving the word *bed* for those forms when they occur in the earth, or in the midst of soft materials, as beds of hematite, manganese, etc.

In those forms which I have called *masses*, there is probably much to be learned by future exploration. As we are unable to see their full extent, we are unable to determine their precise nature. We, in fact, do not know but that they are extended rocks of ore, beneath all the others of which we have any knowledge.

Of the two forms in which the magnetic oxide occurs, I shall mention first, that which I have called a *mass*, which I have defined a quantity of ore inclosed irregularly in the midst of rocks, whose extent laterally, or in the direction usually called width, is unequal, and whose lines of demarcation between the ore and rock are indistinct and ill defined. Of this form are the ores of Adirondack, in the west part of Essex county. I have, at different times, entertained different views in regard to the form in which these ores occur; at one time calling them *beds*, and at another, *veins*, neither view being satisfactory. I have at last called them neither one nor the other; adopting the above as more expressive of their appearance than either of the others. Should I attempt to describe these masses, I could convey an idea of them in no better language than to speak of them as ledges, cliffs, or rocks of iron ore; exhibiting the same structure, natural joints, or divisional planes, as other rocks. Such is certainly the structure in the midst of the mass; but when the ore is situated near the rock, it gradually takes in a greater proportion of earthy matter, or portions of the rock, and perhaps becomes incorporated therewith; but at other times, it sends out branches into the adjacent rock, as in the annexed sketch, which though they often appear to be cut off from the main mass by the interposition of rock, yet can in most instances be traced to it by oblique prolongations, as seen in the cut, (fig. 21.) In other instances, the mass passes clearly

21.



a, Mass from which the veins of ore proceed ; *b*, Rock.

beneath the adjacent rock, if appearances are not deceptive. If so, it is a step towards proving the diversity of materials in the earth, and accounting for the greater gravity of the earth as a whole, than that of its crust.

So little can be determined by observation, that reliance cannot be placed on speculations of this kind. The naked fact is, that after tracing the ore continuously for five or six hundred feet, it disappears under the rock of the country. How far it extends, and what is the nature of the termination, cannot be known until the upper rock is removed. Neither do we know much in relation to its depth, from actual inspection ; for none of the masses in this region have been penetrated more than twenty or thirty feet. But in this distance, two important facts are revealed : 1st, that the ore becomes purer and richer ; and 2d, that portions of rock,

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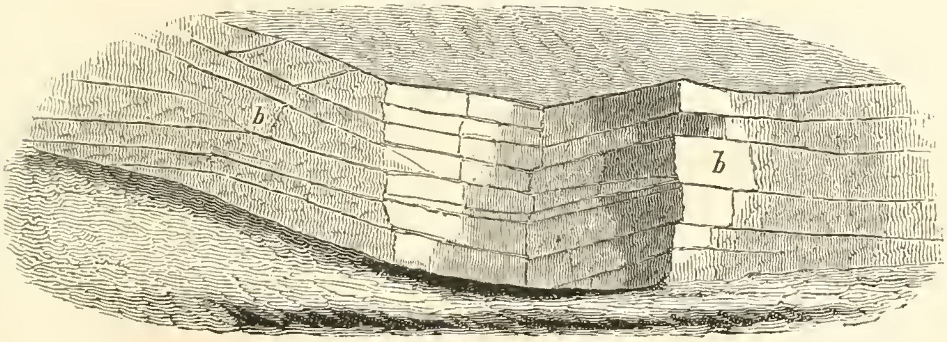

Mass of fine-grained ore at Adirondack.

which projected into the mass, disappear. I have, in the annexed diagram, represented this fact, as it appears in one of the excavations at Adirondack. The mass often presents the appearance of stratification, being divided by planes into layers from four to ten inches thick, parallel with which is the layer of rock *b*. This layer, however, was thicker at the surface,

and continually diminished till it nearly thinned out. This kind of wedge-form shape or projection is very common in all collections of ore: it is often called a *horse*, by miners; though it is to be distinguished from a dyke, which is also called by the same name; the latter is trap, or greenstone, and cuts obliquely through the ore from side to side; but the former is composed of the same material as the rock, and is merely a projecting part of the same. A fact worthy of notice, and which may be given in this connection, is the appearance of small garnets adjacent to strings of ore which branch out from the mass, fig. 23. The shaded part

23.

is hypersthene; and the iron ore is represented in thick black contorted branches, and the garnet appears in the dotted border of ore. Whether the garnet is any way connected with the origin and former state of the magnetic oxide, cannot be determined, but geologists are in the habit of regarding analogous phenomena in this light.

Original Formation of Masses.

Masses of ore appear to be coeval with the rock which encloses them; or, such a view comports best with many facts and phenomena which are brought to light in mining. If this is sustained by future investigations, it will necessarily follow, that the original formation must have been influenced by the same agents as those which were concerned in the production or modification of the materials composing the rock. The rock which encloses the ore is clearly unstratified; from which fact we are also to infer the igneous origin of the inclosed mass of ore. We are clearly driven off from every other mode of formation: the theory of electro-magnetic agency appears out of the question. The subject, however, must remain open to future investigation. The time will come when these mountains of ore will be laid open, and their structure more perfectly revealed, and the relation subsisting between the rock and the ore disclosed to the light of day. We wait till then for a satisfactory solution of this interesting and important problem.

For a general view of the masses of magnetic oxide at Adirondack, I refer the reader to

two plans, one of which is on a large scale, to show the thin vein of iron which projects from one of the large masses into the rock; the other exhibits a plan of all the important masses which have been examined in this immediate vicinity. There is no attempt to exhibit the real shape or form of the masses; this forms, however, a remarkable contrast with the views of the same mineral in Peru, and in many of the adjacent towns where gneiss is the predominant rock. (See Plates III. and IV.)

Veins, their Structure, etc.

In their form, they are unquestionably lodes or genuine veins, sometimes of considerable longitudinal extent, and often coinciding nearly in direction with the strata. They are between walls of gneiss or granite, varying in width from one to thirty or forty feet. The rock, however, is rather a granitoid gneiss in many places; in others it is hornblende, the belt of country being underlaid principally by a rock which in the main is stratified, but its character in this respect is not well marked. The more perfect the stratification, the more distinct are the veins.

An important feature presents itself in regard to the distribution of the magnetic oxide through the northern counties: it is its occurrence in parallel belts, for rarely do we find a single insulated vein or mass. This feature is one which is favorable to the manufacture of iron; increasing the quantity of ore, and furnishing it of different qualities, some of which are adapted to the manufacture of bar, and others, to that of pig iron and other castings.

I remarked above, that the direction of the vein often coincides nearly with that of the strata; this applies to the dip as well as to the strike. For limited distances, the coincidence is often perfect, still, in most cases there is a deviation; the vein, as it comes up from below, passes through the strata, and not between them; and as it is traced longitudinally, it will be found to cross them in its onward course. The common strike of the veins is north-northeast and south-southwest, yet it is not constant. The amount of dip varies from thirty to seventy-five or eighty degrees.

The veins of magnetic oxide may be described comprehensively, as consisting of ore and other minerals, particularly limestone, hornblende, feldspar and quartz, all of which are arranged longitudinally, somewhat in parallel stripes, the ore frequently forming the smallest part of the vein. Its usual arrangement is in rather ovoid masses, disposed with the longer axis in the direction of the course of the vein. Sometimes they are numerous and small, being strung together, and touching each other at their points; in others, those masses are large, extending many feet, the same arrangement being preserved, and each ovoid mass of ore being separated from others by a thin partition of the gangue. But there are instances where the vein seems to be composed mostly of ore; and others in which the foreign minerals are about equally diffused in the vein. Where such a structure and arrangement prevails, the foreign mineral is mostly quartz, and the ore in the rock presents a mixture of black and grey, the latter being sprinkled over or through the dark ground of ore.

Another feature worthy of notice, is the liability of the vein to be shifted or moved to one

side. A portion of a vein, on being cut through by a dyke, is often moved to the right or left the whole of its width, and frequently more. As these shifts occur at or near where it is crossed by a dyke, it is generally supposed that they are the agents by which these derangements are produced, though it is by no means clear that they are really the cause, inasmuch as we must suppose a fissure existed prior to the injection of the dyke. It is true, that we may conceive that the force which caused the molten rock to occupy and fill a rent, would also act with some power upon the strata, and perhaps tend to increase the extent of the fracture. The shiftings and other derangements are not so frequent, neither are they so extensive, in the iron region of the north, as in other mining districts. They rarely occasion any inconvenience, or extra expense in the progress of working them.

It is an interesting fact, too, that though the matter composing a dyke never mingles itself with the ore, yet it alters its character and quality. That portion of the ore which lies near it, works differently, though no external difference appears to the eye, from that which is taken from a distance. I believe this change is unfavorable ; that such ore is not reduced in the forge so easily, neither does it make an iron of so good a quality as other parts of the same vein. This fact favors the opinion sometimes expressed, that the kindness of working, and the quality of metal, depend much upon the structure, and not altogether on the composition of the ore.

4. Specular Oxide of Iron.

Distinguishing characters, position, relations and disturbances occasioned by it and its associated minerals.

The specular oxide of iron, as it occurs in the northern counties, is in two conditions : 1st, that of a red powder, or red mass, which strongly soils whatever comes in contact with it ; and 2d, in brilliant, highly crystalline particles or crystals, with the lustre of polished steel. Notwithstanding the external difference in the two conditions, they are the same chemically, the iron in both being in a state of peroxidation. Both varieties are found associated together in the same mine : hence, it appears that the former is merely a disintegrated form of the latter. It is readily distinguished from the magnetic oxide by its red streak, or the red color of its powder, and by its want of magnetism.

Form and Geological Position of the Specular Oxide of Iron.

As in the magnetic oxide, so in the specular, there are two forms in which it is found : 1st, that of masses ; 2d, that of veins. The former is the most common, and is the only one which has furnished hitherto a sufficient quantity of ore for the supply of the different establishments for the manufacture of iron. In form and condition, the masses of specular oxide resemble the magnetic ; there are no regular walls or regular boundaries, so far as they have been opened and exposed to inspection. We find them, therefore, extending laterally rather than in depth ;

for, in many points, the masses have been penetrated through, and to the rock beneath, and upon which it appears to rest.

In order to exhibit this form, I shall give several diagrams, which will serve to illustrate its mode of occurrence, as well as the geological relations of the rock itself.

The first in order, is a section of the Parish ore bed in St. Lawrence county :

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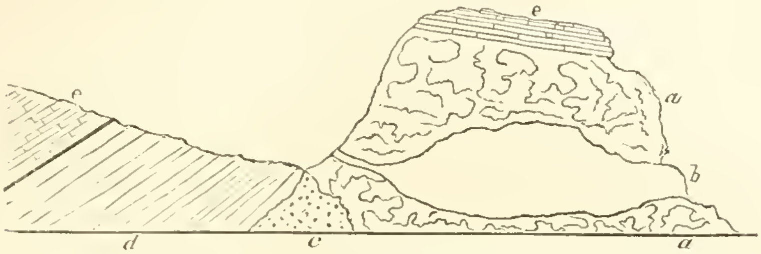

a, a, High bluff of specular oxide ; *b,* Adit which has been cut through the hill ; *c,* Serpentine ; *d,* Gneiss ; *e, e,* Potsdam sandstone.

This mass covers a wide area ; its extent has not been determined by the excavations, but its depth, particularly at the south end, is found to extend to but eight or ten feet, as the ore is cut entirely through, so as to disclose the serpentine beneath. It appears, from an inspection of the locality, that a large amount of ore must at some former period have been swept away, as there are extensive removals of rock and materials which must once have covered this particular mass.

The next diagram of this series, (fig. 25,) shows a continuation or extension of the Parish bed to the northwest about forty rods, where an extensive excavation has been made, which is called the *Kearney bed.* A few rods to the south of the Parish, and also to the north of the Kearney bed, we find the Potsdam sandstone ; at the former place, dipping to the south, and at the latter, to the north ; or, in other words, thrown off in opposite directions from the masses of ore. An arrangement of this kind clearly indicates the nature and cause of changes at this place, which appear to have resulted from an uplift, or an outburst of the ore in connection with the serpentine beneath it. That the serpentine and the specular oxide were the

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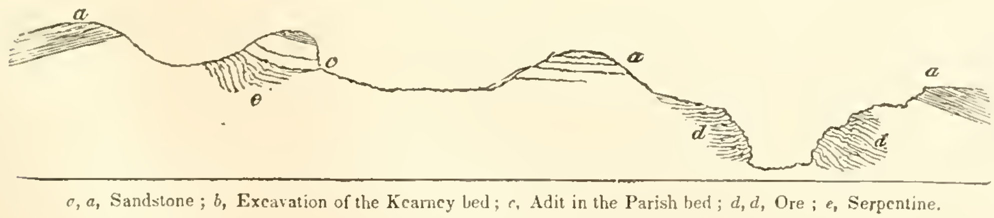

a, a, Sandstone ; *b,* Excavation of the Kearney bed ; *c,* Adit in the Parish bed ; *d, d,* Ore ; *e,* Serpentine.

rocks which created this disturbance in the position of the sandstone, seems highly probable from the fact that no igneous rocks, as trap or greenstone, appear in the vicinity. This fact,

taken in connection with those which have been already given of the nature of serpentine, carries with this view a high degree of probability.

There is one point of great theoretical and practical importance, which it is proper to state in this place; it is, the great difference in the quantity of ore contained in masses at different places. Thus, at one place it may extend only a few yards, or consist of only four or five hundred pounds, and in some instances even less; while in others it forms wide extensive beds, whose limits are not yet ascertained. In all those instances, I have observed a connection with a supposed igneous rock, as serpentine, or primitive limestone.

Another interesting fact is disclosed at some of the leaner beds of this ore which have been opened at Theresa. The ore is arranged in indistinct layers in the Potsdam sandstone; these layers appearing to have been originally this sandstone only, but subsequently filled or saturated with the oxide of iron, some of which, if found in any other place, as in boulders, would have passed for quartz highly charged with iron. But at the locality referred to, there are rich masses of ore interspersed with the lean; and withal, serpentine appears too, pushed into the mass, and occupying an important place, as in the Parish bed. The third diagram of this series, (fig. 26,) illustrate the observations I have just made.

26.

a, Serpentine; *b*, *b*, Specular oxide.

In fig. 26, there is the same disturbance as at the Parish and Kearney beds; the fracture of the sandstone, its elevation, and anticlinal dip. This diagram illustrates the position and relations of the masses at the Shirtleff bed, four miles east of Theresa falls.

I can offer but little besides conjecture of the extent of the masses of the specular oxide, as they are revealed by uplifts along or near the borders of the primary and transition formations. The sandstone is of course thin and irregular in its extent; and the disturbances which have taken place, are all favorable for bringing to light masses of ore which may exist in connection with it. As we recede from this border towards the deeper portions of the transition rocks, the fractures are less in extent, and rarely, if ever, sufficiently great to bring to light beds of mineral matter which may be interposed between the two classes of rocks.

As an additional illustration of the position of this ore, I have added fig. 27, where the mass

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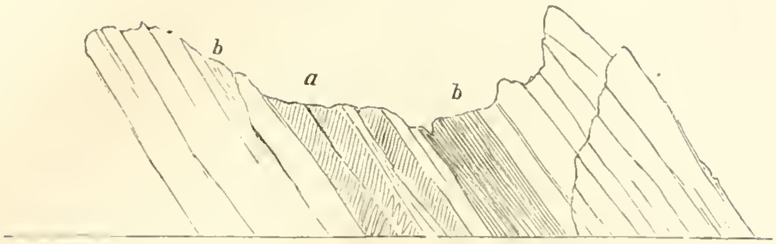
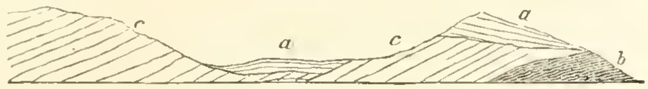


is represented as still in connection with the Potsdam sandstone and serpentine, but the beds are tilted up to a greater angle than usual. *a*, is serpentine highly charged with quartz ; *b*, *b*, sandstone, intimately mixed with the peroxide of iron, with which also there are rich masses of ore.

Before leaving the phenomena presented in the masses of specular ore, I will give two additional diagrams, in which some diversity may still farther be seen. Thus, the diagram fig. 28, shows the position of a lean red ore at Fowler.

28.

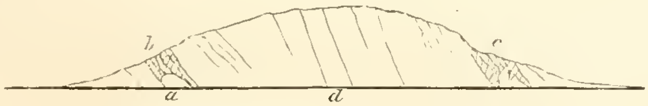


a, Potsdam sandstone ; *b*, Red ore, with serpentine ; *c*, Gneiss.

The ore at this locality is a red rock, apparently stratified, lying between layers of gneiss, over which the sandstone partially projects. The mass of ore is not, therefore, interposed simply between the sandstone and gneiss ; or if an interposition exists, it is to be regarded as accidental, and not a true geological position.

But to illustrate more satisfactorily the true geological position, I will introduce a diagram taken from the Tate and Polley beds in Hermon, (fig. 29,) the Potsdam sandstone being absent.

29.



a, Serpentine ; *b*, Tate bed ; *c*, Polley bed ; *d*, Gneiss.

If now we imagine those beds to have been overlaid by sandstone at the time of the eruption of the ore, accompanied by serpentine, we can conceive that it would have penetrated into the lower layers, and have presented phenomena precisely similar to what we now see at the Parish bed, and others in Theresa ; and a partial disclosure of the mass would convey

the impression that it might have been an aqueous deposite upon the gneiss, and previous to the formation of the sandstone ; and that the serpentine, which is so constant an attendant on the ore, was merely a peculiar mud. But taking all the phenomena together, it is evident that such an explanation by no means meets the case ; and furthermore, that it is more rational to suppose the ore and serpentine to have been forced out from beneath through pre-existing fissures.

Serpentine Breccia.

I have already adverted to the singular breccia formed of serpentine and quartz, among the beds of specular oxide. At first, the green mass which I have so constantly found in them, was not recognized as serpentine ; and it was not until after a careful examination, that I was satisfied of its being this rock. Usually the quartz is so perfectly incorporated with it, that it appears to be cotemporaneous in its origin ; but I fell in with masses of it at the Sterling bed in Jefferson county, where it is perfectly easy to separate the angular mass from the rock, and in this state they present no appearances of a union or incorporation with the mass at all, no more at least than what would take place by the inclosure of the fragments in a paste which forms the breccia of any rock, whether volcanic or aqueous.

Topographical Position of the Specular Oxide.

The topographical position of the specular oxide is, for the most part, in valleys, a position due to the physical changes of the surface of the country. There has been first, a slight upheaval of the beds of sandstone, beneath which lie those of the oxide of iron. In the second place, currents of water have swept over the surface, bearing away the loose fragments which had been formed by fracture, and also apparently extending wider and deeper the breach of continuity by abrasions.

It appears from an inspection of the surface in the immediate vicinity of these beds, that a large amount of ore has been swept away and carried to the south, to form new deposites, which will be found to consist of the peroxide of iron, in combination with lime, silex and alumina. Such a combination we find in the oolitic and argillaceous iron in the county of Wayne, and also far westward. I have even seen masses of the ore in boulders, far south of any of the known beds of the specular oxide. It is not my purpose, neither is it my province, to speak of the argillaceous ores south of Lake Ontario. Neither do I suppose that the same current which transported the boulders of the specular oxide, and which we find intermixed with diluvial, transported also the materials which compose those ancient beds of the oolitic

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Note. It is clear that the specular ore in Jefferson and St. Lawrence counties is much older than the oolitic of Wayne, and that the latter must have been derived from a distance, and deposited in the same manner as the sedimentary rocks in connection with it. But the diluvial action which transported the boulders of this ore south, and which we now find upon the surface, was much more recent than that which carried the ferruginous matter into those seas in which the oolitic ore was deposited. Still it is not improbable that the beds of specular oxide at the north may have furnished the materials for the beds of ore at the south.

ore at the south. The former belong to a modern period comparatively, while the latter is very ancient. Still, the facts that the masses at the north exist, and have been so remarkably broken up by forces acting beneath, and by currents above, are not to be lost sight of in our geological researches.

Origin of the Magnetic and Specular Oxides of Iron.

I have had occasion so frequently to refer to igneous action, in my remarks upon unstratified and subordinate rocks, that I have already anticipated the views which I am about to present of these two oxides. It will be seen from the structure of the diagram, and from the general bearing of the facts, that such an origin is by far the most probable, though there are many geologists who maintain the theory of electro-magnetic agency; and it must be conceded that it possesses many plausible points, and a few facts which lend it some support. Still as it regards its establishment, it appears from the researches of Faraday, that we should be obliged to sustain it on the assumption that the materials must have been in a liquid state at the time of their formation; as the principle of electro-magnetism has no power to act upon a substance, so as to transfer it from one point to another, if it is in a solid or aëriform state. Electro-magnetism, though it decomposes water, is unable to act upon ice, or to decompose any other substance when solid; this at least is the case in the experimental researches of the most eminent philosophers of the day, in relation to the decomposing and transferring power of this agent.

The igneous origin of both oxides rests partly, as already stated, upon the establishment of the plutonic character of the rocks associated with them, and partly upon the mode of their occurrence in those masses. It is true, that the specular oxide appears among the lower layers of a sedimentary rock; but a careful inspection will satisfy most observers that it appears here as an intrusive rock, and that it has been forced into this position subsequent to the deposition of this sandstone; the evidence of which appears in the facts which have been stated in the preceding pages, viz. its fractured and upraised position. And it is not at all remarkable that a porous sandstone should have been penetrated by this material, so as to appear somewhat homogeneous, when we consider the forces which must have acted previous to, and during its upheaval.

I have noticed, also, and it is a fact which has the same bearing as the others already stated, that some portions of the rock adjacent to the ore are porous, or somewhat vesicular: the pores are, however, quite small, but still they are quite characteristic, and are clearly different from that kind of porosity which arises from decomposition; they appear, in a word, like those in the sandstone of Connecticut river, in the vicinity of the greenstone trap. Of the origin, then, of the oxides of iron, there are a variety of facts of the same character, which, when observed in other rocks, have been considered demonstrative of an igneous origin: if, then, we are not in error in relation to principles already received, we can scarcely refuse to apply them to the question of the origin of the ores of iron.

In concluding my observations on the origin of the ores of iron, I feel more desirous of

stating facts than giving theories. Every day brings to light new facts which bear upon this question; and it would be premature now to expect to present a view, in the present stage of mining operations in this country, which will be free from objections. All, therefore, which I would upon the whole be understood as saying, is, that so far as facts have been revealed, they go to the support of the igneous origin of these ores.

In this place I deem it important to say one word on the uncertainty of mining operations, when carried on in connection with rocks whose origin is similar to that of serpentine and primitive limestone. Experience has shown us, that every visible particle of ore may be removed from those rocks, without leaving a trace by which the miner may push forward his operations. Frequently in gneiss the vein diminishes in width, till it is a mere string; but this serves to direct the operations farther, and which, if pursued, lead to its enlargement or expansions; or sometimes a lateral shift throws the vein to one side. In either of these instances, the miner is not left without rules and guides by which to recover a lost vein. Not so, however, in the veins or masses in serpentine and primitive limestone. The whole mass, after being quarried out, leaves no trace of the direction in which it may be found. There is neither a string or line of ore, nor a shift, as in mines in other rocks. The probability is, that abundance still exists; but in what direction it is to be found, cannot be told.

An examination of all the relations of the rocks, and of collateral facts, lead to the assumption that a quantity of the ores was inclosed in a moulten mass of limestone or serpentine, which completely insulated it from the great reservoir from which it was derived. There may be many instances in which the insulation is incomplete; a narrow neck may remain, by which the great mass may be discovered. The large masses, such as the Kearney and Parish beds, have not been explored sufficiently to test this question; but many small ones have been entirely removed, without any evidence of an extension in any direction, or of a connection with a larger mass beneath. Facts of this kind are very important to be known, and should lead to caution in the investment of capital, either in the direct purchase of the mines themselves, or the erection of establishments for the manufacture of iron.

CHAPTER V.

NEW-YORK TRANSITION SYSTEM.

Sedimentary Rocks of the Northern Counties belong to the lower part of the Transition System, and form only one Group. — Lithological characters. — Fossils. — Potsdam Sandstone the lowest member: Limestones succeed; Shales next, the upper portion Sandstone. — Thickness of the whole mass.

The Transition rocks of New-York constitute, as a whole, the most perfect system which has hitherto been described. To be satisfied of the truth of this assertion, we have only to trace out the rocks which successively appear on the southern slope of the Adirondack range. Proceeding from the base of this range, at the most northern outcrop of the lowest of the sedimentary rocks, in a southwesterly direction towards Pennsylvania line, we pass over an unbroken series, which fills up the space geologically between the primary and the old red sandstone. In the whole space, such is the order and regularity in the succession, that we meet with no unconformable masses, nor sudden and abrupt passages from one group or series of rocks to another. There is a gradual sequence or transition from one mass to another; so much so, that it is indeed difficult for the geologist to determine to which series a given rock belongs.

The remarkable series which fill up the space between the Primary and the Old Red System, constitute together the New-York Transition System. It is composed of several groups, which, as they cannot be considered strictly natural, it becomes necessary to define their limits arbitrarily, and to bring to our aid geographical boundaries; observing to draw the boundary lines, when it is possible, through those neutral planes where the masses appear to coalesce. To these geographical ranges, series, or groups as they are usually termed, it has become customary to give geographical names. To this custom there appears but few objections, so long at least as descriptive or characteristic names are so difficult to be obtained, and so likely to prove productive of error, or at least of uncertainty. They answer the present purpose, and serve one good end; that of directing the inquirer to those localities where a particular group, or individual rock, is best developed, and its relations best disclosed.

The rocks of the northern counties, or those which form the Second Geological District of

the New-York Survey, are the lowest beds of the Transition System; they rest immediately upon the Primary, and though among themselves there is no unconformability, yet in many minor districts they are quite disturbed and broken up, especially near the line of junction between the transition and primary rocks. As we recede from this line to the deeper parts of the transition, they become quite regular, being scarcely disturbed or moved from the original position in which they were deposited.

As the rocks which constitute the lower part of the mass of the Transition system have hitherto received very little attention, it became necessary not only to investigate with great care their characters and relation, but also to provide them with suitable names. After having given them the attention and care they seemed to require, I have, with little hesitation, concluded that they belong to but one group. Although there is a great diversity in the lithological characters, still the fossils appear to belong to but few types, and to those which are strictly related to each other. In this single group, the fossils appear to be allied; but when we leave the upper member, and pass to the Medina sandstone, we find a distinct change in the character of the fossils. It is here we first meet with the Fucoides harlani; but up to this rock, certain genera and species of shells run through the entire mass, as Leptæna, Orthis, Atrypa, Delthyris, &c. Although these genera are not confined to the lower rocks, yet certain species, with very few exceptions, are confined to this lowest group; and it is not only so with the Testacea, but also with the Crustacea; thus, the species belonging to the genera Isotelus, Trinucleus, Calymene, Illenus, etc. are mostly confined to it. One remarkable Polyparia, known as the Fucoides demissus, appears to belong, so far as researches have yet extended, to these lower rocks. I do not, however, propose in this place to go into the characters of this group: the individual members will be described in their proper places, when I shall give a full account of their fossils, and the characteristic features of the several rocks composing them.

The name which appeared the most appropriate to this group, is derived from the lake along which they are so well developed, (I refer to Lake Champlain); hence it becomes the *Champlain group.* Although it would have been perhaps desirable to have selected one from a town or locality, still there appear to be no strong objections to its use and adoption. In the first place, all the rocks and masses, without exception, are found not far from its borders; and besides this, the whole is so accessible, that it is no small recommendation to its adoption. The name, too, is one which may well be considered less local than any other which could be selected: it is, as it were, a *national name.* Surrounded as it is by allied rocks, and bordered by two States, and extending into one of the British Provinces, it appeared more likely to be sanctioned than one derived from any locality within the limits of the Second District.

Following out the plan of the nomenclature for the rocks of New-York, I have considered that, for purposes of study, they might be arranged in four groups, as follows: Champlain group, at the base of the Transition system; Ontario group, comprehending the rocks which lie upon its southern border for about fifteen or twenty miles; the Helderbergh series; and lastly, the Erie group, which completes the whole series of the system, extending up to the old red sandstone. These four groups are tolerably well defined: they are, at least, so loca-

lized that they admit of being studied in this order; and it is an interesting fact that we commence on the east with the Champlain group, a little above the level of the sea; we then ascend up to the Ontario, and finally the Erie, which is the highest, both geologically and geographically. The Helderbergh rocks can only be studied in the range of highlands bearing that name, as they mostly disappear towards the centre of the State, though one of the most important members remains in full force, viz. the Helderbergh limestone.

Another interesting fact, in connection with the great divisions of the Transition system, is, that the lakes which furnish respectively the names for three of the proposed groups were excavated out of those rocks. Thus, the valley of Lake Champlain is excavated out of the Champlain group; the valley of Lake Ontario, at its southern extremity, is excavated out of the shales, sandstones and shaly limestones which compose the Ontario group; and the Erie, out of the Ludlowville shales, shaly sandstones, etc. which also compose the Erie group. The Helderbergh series are well defined and limited: At the base of the Helderbergh mountain, an uplift, which brings into view the Champlain group, just elevates it sufficiently to conceal the Ontario group, so that it leans against it on the line of the upper rocks which compose the latter group: as if a hand had been placed purposely to conceal all the lower rocks, and leave the entire mass of the Helderbergh series above, for the study of the geologist; and that the whole connection may be seen, we find the summit of this range, the Erie group, very well developed, the Helderbergh series lying between the Ontario and the Erie groups.

The above remarks will give a glimpse of the value of this grouping for the purposes of study. In order to study the Champlain group, we go to the valley of the Champlain; and it is the only valley in the State, where all the rocks composing it are found: the Ontario group is well developed all along the southern shore of that lake, particularly at Rochester, Lockport, and on the Niagara river. To study the Helderbergh series, we may cross the range at New-Scotland, near Clarksville, commencing our examination at the base of the mountain below the pentamerus limerock; as we proceed up, we find in succession several well marked members of the series, all lying beneath the Helderbergh limestone, which terminates the series in this direction, and all of which clearly underlie the shales and shaly sandstones of the Erie group, which occupy the crest of the mountain. But our view of the Erie group is not perfect in the Helderbergh range; and in order to see all its members, we must go west and southwest, or to the shore of the lake itself. It is not supposed, however, that its immediate shore will furnish a complete profile of the rocks which I would propose to place in this group: it will undoubtedly require many offsets from the lake, in the direction of the excavated valleys formed by the streams which flow into this great reservoir.

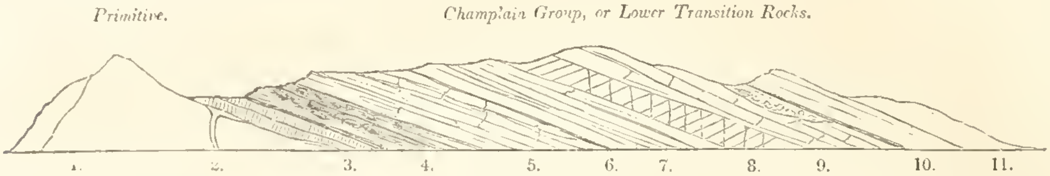
Taking, then, a comprehensive view of the whole ground of this grouping, (for which I am alone responsible,) it appears to be adapted to the purpose for which it is proposed; for, on examination, the student will see that the outlines of the Transition System, as well as the minor parts, as developed in New-York, are drawn through those planes which are termed *neutral*, and that neither group contains members which clearly belong elsewhere. It is true, the number of groups may be greatly increased; but should we not be in danger of defeating the object aimed at in classification? It is the simplicity of the view which recommends itself

in the grouping proposed; while it leaves us at leisure to subdivide, if necessary, and study the several groups as minutely as we please, or as the nature of the formations require.

CHAMPLAIN GROUP.

Some of its most important characters. — The order of succession, or the superposition of the members composing it.

Returning now to the consideration of the members of the Champlain group, I shall present, in the first place, a section giving the names and the order of succession of the rocks composing it.



1. Primary; 2. Oxides of iron; 3. Potsdam sandstone; 4 Calciferous sandrock; 5 Chazy limestone; 6. Birdseye limestone; 7. Trenton limestone; 8. Utica slate; 9. Lorrain shales; 10. Grey sandstone; 11. Medina sandstone.

1. Potsdam Sandstone.

Disturbances. — Fossils. — The base of the Transition System. — Diversity of materials.

The base of the Transition system of New-York is the Potsdam sandstone. Its lowest portion is a granitic conglomerate, in which large masses of quartz, the size of a peck measure, are often enveloped: they are rounded and water-worn, and held together merely by a finer variety of the same materials. The part which is properly a standstone, presents some variety of aspect and texture at the different places where it appears; but there are two principal varieties, which it may be well to notice: 1st, an even-bedded and somewhat porous rock, at many places a distinct white friable sandstone; in others, it is a yellowish brown sandstone, the particles of which are compacted together, so as to form a firm even-grained mass. The rock at the Potsdam quarry furnishes a good variety of the latter; those of Bangor and Moore, of the former. 2d, a close-grained, sharp-edged mass, with natural joints traversing it in two principal directions, so as to divide it into acute rhomboids, so closely wedged together that it is with difficulty quarried. It is, in fact, a hard quartz rock, scarcely passing for a sandstone. Keeseville, Whitehall and Port Kent furnish examples of this

variety. At those localities where it is strictly a sandstone, it appears to have been formed of the debris of granite and gneiss, as, besides quartz, small particles of feldspar and fine scales of mica are disseminated through the mass; the latter is not, however, very common—not so much so as many of the later formed sandstones. The fine-grained hard variety is mostly homogeneous throughout, and it rarely presents distinct fragments of feldspar or mica. To the eye, it is pure silex; but it probably contains, in intimate combination, particles of both feldspar and mica, but ground to extreme fineness.

It will be necessary to describe two or three other varieties of this rock, which, however, appear to be more local than the two varieties already noticed. At the Falls of Montmorenci, this rock is stained with carbonate of copper, which, being intimately mixed with an impure earthy portion, gives it the aspect of one of the varieties of the new red sandstone; and it would be very likely to mislead the observer, if seen in almost any other connection. Another variety is the white saccharine sandstone, so friable that it is easily crushed in the hand; in fact, it forms a pure white sand by disintegration. But a more perplexing variety is found at Chazy: it is a calcareous breccia, formed partly of sandstone and fragments of a dirty grey calcareous rock; it is an unsightly mass, and comes in near the termination of the rock, or at its junction with the calciferous sandrock. In connection with this, there is still another, which is a dark iron-brown mass: the particles are more angular than common, and it is traversed in all directions with veins of segregation; in detached pieces it would pass for a variety of greywacke. In addition to the above, we find very constantly a dark slaty sandstone, with impressions of those remarkable relics, called *fucoids;* it is a mass ten feet thick, intervening in some places between the Potsdam sandstone and the calciferous sandrock of Eaton.

From these facts, it will be seen that the termination of this rock is somewhat remarkable. In one place, it gradually passes into the calciferous; in another, the upper layers are brecciated, forming a very coarse rock; in another, it passes into an argillaceous sandstone with numerous fucoidal impressions. It is, therefore, clearly distinct from the succeeding rock, though some geologists have taken a different view of it, and have been disposed to place the calciferous and Potsdam sandstone under one head.

The lithological description of this rock would be incomplete, were I to omit to notice the mass upon the northern, or Canadian slope, where a large proportion of the rock is a conglomerate. In most places where the lower mass is in view, it is, as already stated, a conglomerate, but it is rarely more than ten feet thick; while upon the Canadian slope, where the mass is about three hundred feet thick, it is wholly made up of coarse materials. In addition to the preceding, a deep red variety occurs at Chazy: it rests immediately upon the primitive rocks. The typical mass which gives name to the rock, is a very even-bedded sandstone; the beds vary in thickness from two inches to four feet; the planes of deposition are perfectly smooth, and separable from each other. A layer of one hundred square feet of surface may be raised, and afterwards split into rails six inches wide and ten feet long; or it may be broken into pieces of the size of a brick, with even edges of fracture. The color is yellowish brown; and when employed for dwellings, it makes an exceedingly neat and com-

fortable appearance. The rock dips 25° to 30° to the northwest, at Potsdam; but situated as it is, adjacent to the primitive rocks, it presents every degree and variety of direction and dip.

Though this rock is generally even-bedded, I have noticed several places where it has been subjected to violent forces, so as to greatly derange the strata. A remarkable instance exists at Dekalb in St. Lawrence county, where the rock, in addition to an elevating force acting beneath it, seems also to have been subjected to a lateral pressure, by which the strata are folded around each other, a representation of which is exhibited in the wood cut fig. 31. In

31.

the cut, the edges of the strata only are seen, and but a small part of the mass so affected is exhibited in the drawing. The locality is about eighty rods north of the village of Dekalb, on the roadside, and can scarcely escape the notice of the most careless observer. Other portions of the same mass show more clearly the effects of lateral pressure; so much so, that some parts of the strata are perfectly crushed or broken up, and appear in fragments, which are displaced as in the cut fig. 32. The rock immediately beneath this disturbed mass,

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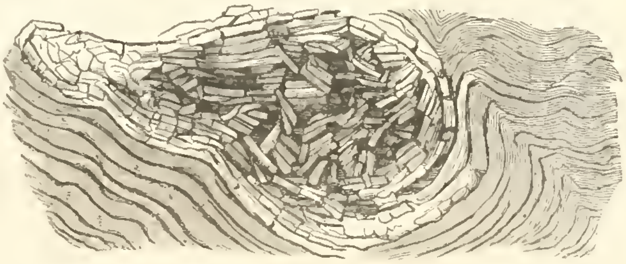

is primitive limestone. The junction between them is concealed, and we are left to conjecture as to the immediate cause of this remarkable disturbance.

The Potsdam sandstone, during the accumulation of its materials, appears to have been subjected to a variety of changes in the kind of the materials of which it is composed, and the

intensity of the forces by which they were transported. In some places, therefore, they are coarse, and irregularly mingled; in others, they are fine, but in large quantities, and appear to have been borne along by a moderate current, which has given a diversity in the stratification resembling that of inclined beds, or beds which have been elevated subsequent to their consolidation, as in the annexed diagram, fig. 33. Phenomena of this character are common to all accumulations of gravel and sand, but do not become evident in any of the argillaceous or calcareous rocks, probably in consequence of the extreme fineness to which the particles are reduced. Among other phenomena, ripple marks may be seen throughout the whole of the rock, when the materials were not too coarse; showing that during the period when this deposit was in progress, the waters were quiet, and free from those disturbances which give origin to a confused stratification.

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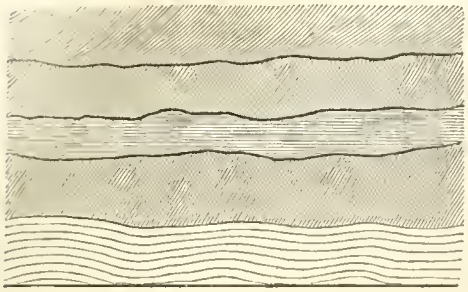


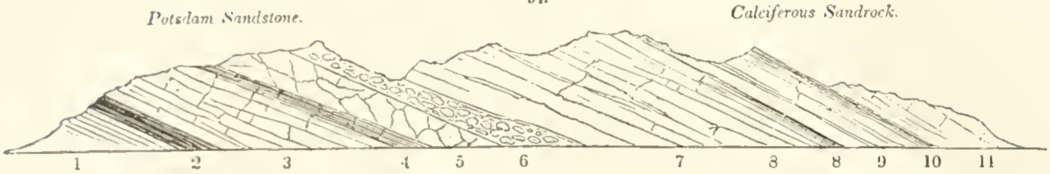
Fossils.—The Potsdam sandstone is extremely poor in fossils; but it is interesting to find even a single bivalve shell, thus setting aside the former crude notions in relation to the order in which beings were created. The only distinct and well characterized fossil of this rock, is the Lingula ovata, found abundantly at the High bridge near Keeseville. It is small, very thin, and rather obscure. It is also found in the same rock at French creek, about one mile east of the village, in a friable variety of the rock. Besides this fossil, another resembling the Fucoides demissus of Conrad, occurs between Wilna and and the Natural bridge in Jefferson county: it is not characteristic of the rock.

2. Calciferous Sandrock.

Mixture of earthy and calcareous matter.—Presence of Calcareous Spar.—Geodiferous.

As its name indicates, it is a sandy limestone: it is not, however, destitute of beds of pure limestone. The mixture of a variety of mineral matter causes the rock to weather unequally; hence it is often rough externally, portions of the siliceous part standing out in relief. This rock is not uniform in its appearance, although there is in general a peculiarity which distinguishes it from the other rocks of this group. There are two quite uniform characters which may be observed in the calciferous, viz. a fine crystalline structure, intermixed with earthy matter, and numerous small masses of calcareous spar. A section will best exhibit the usual order of the varieties which compose it, and which I have placed under this name.

31.



1. Potsdam sandstone ;
2. Fucoidal layers :
3–10. Calciferous sandrock ;
4 Drab colored layers, or water lime ;
5. Cherty ;
6. Geodiferous ;
7. Strata filled with a species of Orthis ;
8, 8. Encrinal masses ,
9. Mass containing the Bellerophon and other univalves ;
10. Oolitic ;
11 Chazy limestone.

Each of the masses noticed in the section will require a few words descriptive of their characters :

1. The common variety, as above, is a sandy limestone, differing considerably in the amount of sandy matter ; it, however, always effervesces with acids. It is never a clear limestone, and its recent fracture is uneven, with a dull lustre or slightly glimmering. It is unsusceptible of polish, in consequence of an intermixture of earthy matter.

2. Towards the lowest part of this rock, there are several layers, amounting in all to about ten feet in thickness, which are drab-colored and entirely earthy ; the texture is always finely granular, and weathers rapidly ; a yellowish brown crust forms upon it, which frequently, on being struck, falls off. These strata, where the earthy materials are not in too large proportion, form a very good water lime. Masses of sulphate of strontian and calcareous spar are not unfrequent.

3. Geodiferous masses are quite common ; the geodes contain calcareous spar, crystals of quartz, sulphate of barytes, sulphuret of zinc : sometimes a single crystal of quartz nearly fills the cavity in which it was formed. It is this portion which furnishes the beautiful quartz of Middleville, Little Falls, and Diamond island in Lake George.

4. Cherty limestone is not unfrequent ; plates of dark colored hornstone intersect the rock in various directions.

The preceding varieties rarely contain fossils ; those which remain to be described, are often filled with organic relics :

5. Two separate masses of this rock are filled with the genus Orthis, and together, they are not less than forty feet thick.

6. Encrinal limestone abounds in the upper part of this rock. There are not less than three distinct masses, which are composed almost wholly of the joints and encrinal rings. It is the only part of the mass which is susceptible of a polish ; these, in consequence of the reddish color of the encrinal fragments, form a very handsome marble.

7 A stratum about fifteen feet thick, containing some univalves, one of which appears to be a small species of Bellerophon ; it is interposed between the two masses which abounds in the Orthis already mentioned. It is a darker colored mass than either of the preceding, more earthy, and siliceous.

8. Oolitic, which forms the upper part at Chazy, and lies below the Chazy limestone. The oolite of this place is in fine particles : but a coarse variety, in masses a foot in diameter, is not unfrequent. No fossils have been observed in this variety, though immedately above and below they are abundant.

The entire thickness of the calciferous sandrock is between two hundred and fifty, and three hundred feet. It is sometimes absent, or a mass of a doubtful character, and quite irregularly bedded, appears as its substitute. This is the case at the Falls of Montmorenci, near Quebec : an irregular mass, representing rather the birdseye, rests immediately upon the Potsdam sandstone.

3. Chazy Limestone.

To the calciferous sandrock, succeeds the Chazy limestone. As a whole, it is a dark, irregular, thick-bedded limestone. At Chazy, it contains many rough, irregular, flinty or cherty masses, which have been found in places once occupied by a species of stone coral. It appears to have been a Columnaria; but generally the columns are so obscure and broken, that it is difficult to determine the nature of the fossil. The mass is not uniformly of the character described. At Essex the beds are more regular, and it presents externally a better aspect, and forms in consequence a better building stone. As a limestone, it is purer than the calciferous. The principal foreign matter is silex in the form of chert, which is mostly collected in those points where the stone corallines are imbedded. It is free from those brown earthy spots so common in the limestone below, and also from the masses of calcareous spar which appear almost characteristic of the calciferous sandrock.

The position of the Chazy limestone is clearly determined at Chazy, lying between the calciferous and the birdseye limestone. This rock is wanting in the valleys of the Mohawk and Black river.

There are three well marked fossils, which first make their appearance in this rock: the Maclurea,* a Trochus, and the Columnaria. Besides these, there are numerous small fossils, which the irregular bedding of the rock partially conceals.

The entire thickness of this rock is not far from one hundred and thirty feet. It is developed at numerous localities along Lake Champlain, particularly at Essex, Essex county, and at Chazy in Clinton county. It appears to be less constant in the series composing the Champlain group, than several others; still, as it occurs in a mass of so much thickness, and at so many places, it appeared to be necessary to notice it as a distinct rock, inasmuch too as it differed materially from the masses below and above it, in its fossils and in its structure.

4. Birdseye Limestone.

Generally a pure limestone: embraces drab colored layers, and similar to those in the Calciferous Sandrock. — Structure. — Organic Remains. — Thickness.

The name for this rock is retained, in consequence of its having been employed very generally by the geologists of this country; and I have been more disposed to do it, as its application is generally well understood. The name, it is true, is not very appropriate, and besides there are other limestones to which the term *birdseye* has been given; still, they are not likely to be confounded with the birdseye limestone of the Champlain group.

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* This fossil was first described by C. A. LeSuer, under the generic name of *Maclurite*, in honor of William McClure. As the termination of the name is evidently erroneous, I propose to change it as above, in order to still preserve the commemoration intended of a most munificent patron of science. It is evident from Mr. LeSuer's citation of the localities of this fossil, that he labored under some mistake, as he gives Eighteen-mile creek as one where this fossil has been found. It probably never has been found above the Trenton limestone.

This rock is perfectly compact in its texture, and breaks with a smooth conchoidal fracture. The only crystalline particles, are those which occupy the space where an organic being was enclosed: thus, the fossil known as the Fucoides demissus, in many places is changed into slender sparry columns; but as a whole, the rock is perfectly compact; and, as in most rocks which give this kind of fracture, it posseses a kind of brittleness, which, by a single smart blow, enables us to break off large fragments of the rock. As a limestone, it is perfectly pure, being free (with the exception I shall make) from silex or other earthy matter. It is susceptible of a good polish, and may be used extensively as a marble: the only objection to it, arises from its brittleness, and liability to fracture in working.

The birdseye contains several layers of a drab color, which may be found suitable for water lime, in all amounting to about ten feet in thickness. These layers present a strong contrast to the birdseye, being granular, and of a yellowish white; while the former is blue or bluish grey, with a slight translucency. This rock is an excellent material for lime, forming probably one of the purest of any in the class of limestone. The lime employed by the Redford Glass Company, is made from this rock.

The fossils of this rock, though they appear in some localities quite numerous and characteristic, are yet very difficult to be obtained: they are either mineralized by calcareous spar, or else, in consequence of the compactness of the rock, and the peculiar fracture and little disposition to weather, it is exceedingly difficult to obtain them except in fragments. I have noticed, however, a peculiar species of Isotelus, an Orthocera, a Leptæna, and a large Cytherina. The fossil which is supposed to characterize the rock, is the *Fucoides demissus* of Conrad. In relation to it, I take the opportunity to remark, that in consequence of having found some additional parts of it, it is evident that it is not a vegetable. It is true, that as usually presented in the rock, it appears like a fucoid; but in many places its structure is either destroyed by weathering, or by crystallization, and here its true character is not revealed. In other instances, it is beautifully exposed by weathering, the internal structure being finely displayed on the surface of those rocks which have weathered smoothly. In addition to this, I have discovered that the outside of the hanging stems are perforated like Polyparia; a fact which clearly indicates the true nature of the fossil, and the kingdom to which it belongs.

I have annexed the following drawings illustrating the structure of this interesting fossil:

35.

36.

The first (fig. 35) presents a view of its structure, as brought out by weathering: and exhibits longitudinal sections of a stem, and the small angular compartments, some of which are nearly transverse sections of a stem.

The second (fig. 36) exhibits a magnified view of an oblique section, showing its cruciform structure.

The remarkable structure brought out in this mode, principally by weathering, very clearly establishes the family of beings to which it belongs: It exhibits a perfect analogy to the class of Polypes, though none of the present species appear to assume this peculiar mode of growth. The following additional illustration shows the mode in which the stems appear to penetrate the beds of limestone with which it is associated:

37.

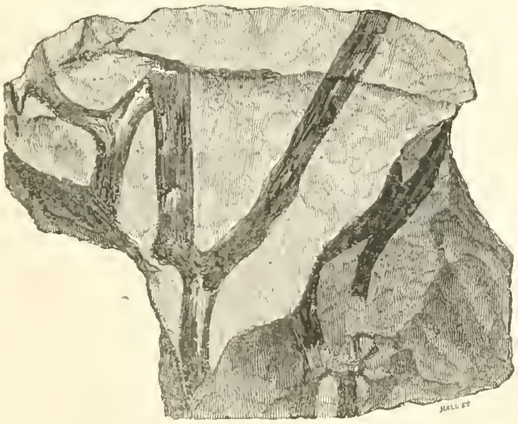


Fig. 37 shows the vertical arrangement of the individual stems and anastomosis, or free intercommunication which existed during the growth of the animal.

38.

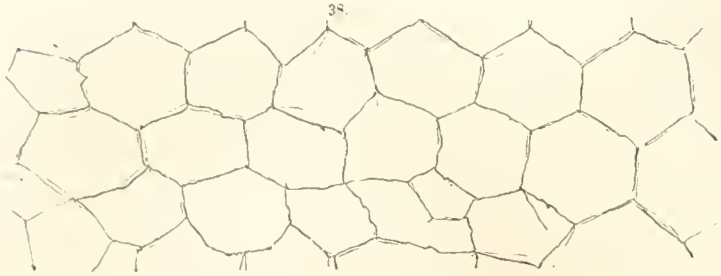


Fig. 38 illustrates the great regularity of this anastomosis, as it appears upon the surface of one of the layers of this rock; though it is rare to find so much regularity, yet the intercommunication appears to have been always more free and regular upon the surface of a layer than during its formation.

A most interesting fact is furnished at numerous places where this rock occurs, but particularly at the village of Fort-Plain in the valley of the Mohawk; it is the sudden extinction of this animal. Thus, on the immediate plane where the Trenton limestone is deposited, this fossil disappears, and no trace is to be seen of it in the succeeding rock; while up to the commencement of the Trenton limestone, it appears to have been in full vigor. The fact that it does not occur in the drab colored layers, though in the midst of the birdseye, throws some light upon the cause of its sudden extinction: they are impure limestones, and the matter deposited with the particles of lime exerted an unfavorable influence upon it. So the Trenton limestone, being composed of aluminous and other earthy matter in part, formed a medium which became unsuitable to their peculiar mode of living.

The thickness of the birdseye is about 30 feet; but like other limestones in this group, it thins out remarkably towards the south. At Essex on Lake Champlain, it appears to be entirely wanting, the Trenton resting directly upon the Chazy limestone. At some other places, it is very thin; but notwithstanding this, it preserves its lithological characters in perfection.

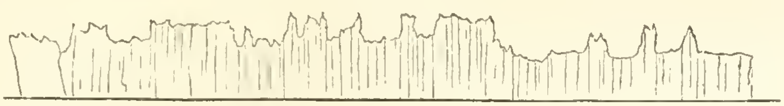
Black Marble of Isle La Motte.

Between the Birdseye and Trenton limestone, there is an important mass whose relations have not been well understood. It is unimportant, so far as its thickness is concerned; yet, as it is largely employed for furnishing one of the finest marbles in this country, it becomes necessary to notice it as a distinct rock. It is a black, finely granular mass, susceptible of a high polish. At the Isle La Motte, it forms as it were but one thick bed, or a single bed comprehends all the workable material for marble. There are planes of deposition separating it into several layers, but they are quite obscure. The mass is about twelve feet thick. A similar mass, occupying the same position, has been wrought many years at Glen's Falls. It is not so perfectly compacted into one thick layer, as at Isle La Motte; but it presents the same fine even texture, and forms a marble equal in value. At Watertown in Jefferson

county, the banks of the Black river are formed of the same rock. It is known by quarrymen as the *Seven-foot tier*. But here, where it is exposed in the banks, it is lumpy, and appears unsuitable for marble, or it does not seem to be sufficiently homogeneous to constitute a valuable material except for ordinary purposes. At Watertown its position is clearly seen, being between the Birdseye and Trenton limestone. Some discrepancies have appeared in the annual reports, in relation to this mass; they have arisen in consequence of mistaking the Chazy limestone for the one under consideration.

This rock has been described as thick-bedded, and rather massive, with obscure planes of separation. Those planes, when separated, are not smooth, as if a partial desiccation or drying took place prior to the deposition of the next layer; but they are quite regularly toothed, or the planes are studded over with projections, many of which are quite sharp and pointed. The diagram No. 39 will explain what I mean, better than words can express:

39.

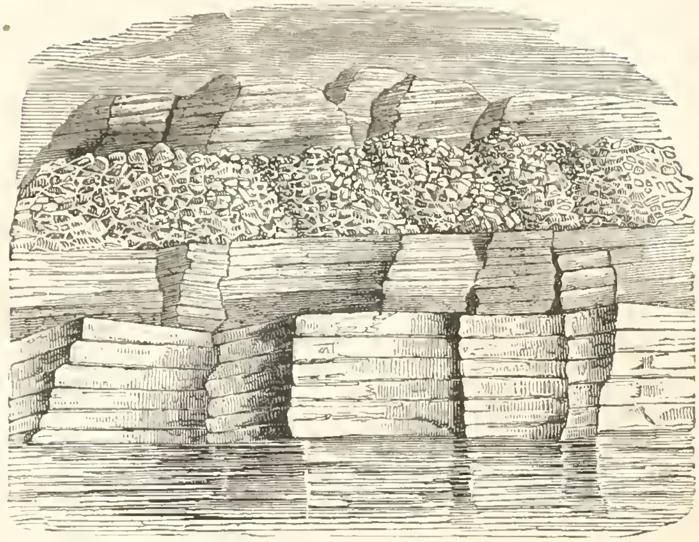


These projecting points are composed of fibrous crystals of sulphate of strontian, from one half to an inch in length. The occurrence of the strontian in this connection, illustrates the manner in which these externally fibrous masses are formed in the Niagara and other limestones; only in the former, the fibrous crystals were soluble, and hence have disappeared, leaving only their impress; while in the latter, the crystals are insoluble, and remain. I have observed the same structure in all the limestones: for its occurrence, it requires a rapid accumulation of materials, and which remain for some time in a soft plastic state.

The fossils of this rock, though not very numerous, are yet worthy of notice. At Watertown, Glen's Falls and Chazy, the Columnaria sulcata is quite abundant, sometimes in masses of the size of half a bushel. Large orthoceratites are also common, some of which are ten feet long, and twelve inches in diameter; they are common also in the birdseye. Another fossil, allied to this genus, is formed apparently of many cones placed within each other, enlarging in the direction of the mouth; or in other words, the fossil is a series of cones within each other.

It is not very clear how such masses as this should be treated; as I remarked in the first paragraph, it is unimportant simply as a rock, and becomes so only in consequence of the valuable material of which it is composed. Were it not for this, it might be placed with the Trenton or Birdseye; yet according to the principles of modern geology, if carried to their full extent, it requires to be separated from both, on account of its lithological characters, and the distinct kinds of fossils it contains: scarcely one belonging to this mass is found to have passed into the Trenton limestone. It is a great evil to multiply unnecessarily the number of rocks; and I am sensible that unless a mass has a greater thickness than this, it ought generally to be merged in that to which it bears the greatest similitude.

40.



A sketch showing the fractured state of the Trenton limestone at Watertown, Jefferson county.

5. Trenton Limestone.

The remarkable series of limestones of the Champlain group, are terminated by the Trenton, which, I may justly remark, is one of the best characterized rocks in the Transition system, both in its fossils and lithological characters. In all the localities of this rock, we find it more or less a shaly limestone. It sometimes occurs as a black thick-bedded rock, with argillaceous matter diffused through it; or in thin beds of limestone, alternating with those of a thin shivery shale. In addition to the masses of limestone and shale arranged as here described, there is sometimes another important one in the form of a grey crystalline rock, occupying sometimes a position inferior, and at others superior, to the black shaly limestone. The black limestone is quite compact in structure, and is susceptible of a good polish, when free from argillaceous matter. The exposed and upper part of the grey variety is often irregularly bedded, loose in texture, and not sufficiently strong for a good building stone; while those beds which are deeper, are firmer, more even, and form a fine material for superstructures. The noble Cathedral of Montreal is composed of the grey variety of the Trenton limestone. The grey, black and slaty limestones are often highly bituminous; they not only emit the odour when struck, but a moisture exhales from and covers the surface of the layers of those newly exposed in the quarries, which strongly soils when handled, and imparts to the hands and clothes the same odor. The relations of the grey and black limestones are not uniform; the former is sometimes beneath the latter, instead of resting upon it, as at or near Watertown in Jefferson county; or else, there are two masses of this color and structure.

However this may be, it is very clear they are both to be considered as one mass or rock, inasmuch as their fossils are identical.

In taking a retrospective view of the limestone of the Champlain group, we may see the very curious and interesting changes which have occurred from one period to another, in the nature of the materials which enter into the composition of these rocks. The lowest of the limestones is very siliceous : this earth, together with an uncrystallizable matter, gradually disappears, when the limestone of the birdseye becomes perfectly pure ; though the peculiar state and condition of the particles is such as do not favor crystallization, excepting in those points where organic matter is inclosed. After the deposition of the latter rock, argillaceous matter first appears, which gradually increases as the deposition of the Trenton limestone progresses, till finally the calcareous matter disappears, being mostly replaced by a dark-colored clay or mud, giving origin to a great thickness of slate rock, shales, etc. We shall find that these are succeeded by a shaly sandstone, and finally by nearly a pure siliceous deposite.

Returning to the consideration of the Trenton limestone, the reader will perceive from the remarks already made, that it may be divided lithologically into two masses : the close-grained black variety, and the grey crystalline one. This division, however, is not so important as might appear at the first view of the subject. It is true, that in Jefferson county, the two varieties occupy distinct geological positions ; but, examined in a wider field, this collocation does not appear to be uniform ; in fact, the relative position is sometimes reversed, as at or near Montreal in Lower Canada. The black shaly mass differs a good deal in its appearance : at one place, it is a very even thin-bedded rock, with regular layers of shale intervening ; at another, it is lumpy, as if the calcareous matter had accumulated rapidly, and taken immediately a concretionary movement, by which irregular oval masses were formed, around which the argillaceous matter accumulated in irregular planes, or planes corresponding to the uneven surfaces which would necessarily be formed under such a condition of things. This destroys all regularity, therefore, in those minor beds, which, by exposure to frost and other agents, are rapidly broken up, and the lumps of limestone become coarse, and gradually accumulate about the beds or at the foot of declivities.

The vignette at the head of this section, exhibits a view of the condition as well as the relations of the rock at Watertown, on the banks of Black river. The lower part exhibits the birdseye, and the *seven-foot tier,* as it is called by quarry men ; the upper part, a portion of the Trenton, the lower layers of which are much broken, while the highest part in the drawing has suffered much less in this way. The process of decay gradually goes on, and the higher layers are finally undermined, when they fall down and assist in forming the talus below.

The Trenton limestone, for causes which will be recognized in these facts, is rarely a good building stone, and still less suitable for marbles, with the exception of the grey crystalline mass already adverted to. The former is shaly, and liable to split and break by the action of frost ; or it is in lumpy masses, still more unsuitable for any purpose except for stone fences, or the coarsest kinds of structures. The grey variety, when even-bedded, is a valuable mate-

rial. Its color, in the first place, is a recommendation for certain kinds of architecture; in addition to which, it quarries easily, and works freely under the hammer. A structure built of this rock, cannot be distinguished at a distance from the grey granites; and judging from its condition and general characters, it is more likely to endure the weather in a changeable climate, than granite.

As the lithological characters of this rock differ from those preceding it, so it differs almost *in toto* in its organic relics. Some of the genera of animals continue, but the species are different; and this fact induces me to remark, that sudden changes were probably more frequent in the early periods of sedimentary rocks, than subsequently; and in illustration of this view, I may refer back to the impure beds of limestone which compose the calciferous sandrock. The subordinate masses of this rock are comparatively thin, from fifteen to thirty feet thick only; and yet they each bear certain fossils which do not appear in the beds above or below, notwithstanding the brief interval which must have elapsed between the successive depositions of these beds; and what renders the view more clear, is the limited number and peculiar forms of the species, together with the great abundance of the individuals. We should expect from the latter part especially, that in masses comparatively thin, the same fossils would continue from one to the other; but this does not appear to be the case: certain species are more clearly confined to those beds which are only a few feet thick, than species ordinarily are in the upper rocks, where they are hundreds of feet thick. But we have, in addition to the fossils of the calciferous sandrock, those of the Chazy limestone, the birdseye, and the limestone of Isle La Motte, and finally those of the Trenton, each of which are perfectly well characterized by its fossils, though they are all limestones, and follow each other in rapid succession. We have, as it appears, a miniature representation of the great fact first noticed by William Smith, (whose country I need not mention,) that strata may be identified by their fossils; and to the northern counties I would direct young geologists for the study of geological principles, especially to Clinton county, where, near the village of Chazy, they will find the facts and principles I have stated amply confirmed. But I recommend a close examination of the strata; for by a hasty one, he would be very likely to overlook the most important facts here disclosed.

The fossils of the Trenton limestone will be fully given hereafter; for the present, I may state that they belong to the following genera: Lingula, Orthis, Leptæna, Atrypa, Delthyris, Avicula, Bellerophon, Euomphalus, Pleurotomaria, Isotelus, Calymene, Bumastus, Trinucleus, and several species of fucoids, graptolites and orthoceratites.

While the Survey of the State has been in progress, the question has often arisen, to what rock in the *Silurian System* is the Trenton limestone equivalent? This question, in the early stage of the survey, could not be answered satisfactorily; for even in England and Wales, the lower rocks of this system were not then well understood or well characterized; but so much progress has now been made, that we are able to make a few comparisons, based on facts, and upon which we may safely reason.

Mr. Conrad, the Palæontologist of the Survey, whose general views are remarkably correct in the early reports, as it regards the general coincidence of the New-York rocks with

the Silurian system of Murchison, gave it as his opinion that the Trenton limestone corresponds to the Caradoc sandstone. This opinion,* founded on the supposed correspondence of the organic contents of the Caradoc sandstone and Trenton limestone, seems, in the opinion of the writer, to have been adopted in too great haste, and from a too limited examination of the New-York rocks. It is not, perhaps, to be rejected on the ground of difference in mineral character; the Trenton being a dark shaly limestone, and the English partly a pure and partly an argillaceous sandstone; still this is one fact which is to be taken into consideration, and so far as it goes, is against this opinion. But leaving out of view the diversity in lithological characters, I see still stronger objections in the organic contents of the two rocks. The Cryptolithus tessellatus of Green, for example, is given as a Caradoc fossil, and is considered as a synonyme of the Trinucleus carractaci of Murchison, or to be the same fossil: this is unquestionably an error. The Cryptolithus of Green is confined to the Trenton mass, but it is by no means the Trinucleus carractaci of Murchison: the latter I have found in the Lorrain shales, and have been able to identify it with the carractaci given in the work on the Silurian system. I would remark here, that it would be better to adopt the generic term *Trinucleus*, in the place of Green's name, *Cryptolithus*. It will then stand *Trinucleus tessellatus;* which, so far as observation has extended, is confined to the Trenton limestone.

If the Trenton limestone is not equivalent to the Caradoc sandstone, to what rock in the English series is it equivalent? To this question, though it is not possible to give an answer perfectly satisfactory, yet I consider it quite safe to remark, that it appears probable that it is the Bala limestone of the Cambrian system. If fossils are to be received as evidence, they go far to confirm this view; thus, among its fossils are the Orthis anomala, *Schlot.*, O. actoniæ, O. canalis, O. compressa, O. flabellulum, O. lata, O. pecten, O. protensa, O. testudinaria, *Dalm.*, Bellerophon bilobatus, and Leptæna sericea. (See Murchison's *Silurian System*, p. 308.) But the geological position of the Trenton is still more conclusive; for on this side of the Atlantic, it is beneath the rocks equivalent to the Llandeilo flags. There is interposed, therefore, several hundred feet of rock between the Trenton limestone and Caradoc sandstone; which, taken in connection with the facts just stated, seems to set aside the opinion of those geologists who have regarded this limestone as the equivalent in this country of the Caradoc of the Silurian system.

I am induced to believe that the disturbances in the English rocks, especially in the lower part of the Silurian system, are such that their composition is extremely obscure, and that many of the masses are not so well developed as in this country, and hence we find great difficulty in recognizing them. I am sensible that it is not so much our business to be seeking for geological equivalents, as to describe clearly our rocks, and to determine distinctly their relations and their order of superposition; still, the work of identification is not useless, and we may derive much satisfaction in discovering the coincidences of position and of character between rocks so remote from each other.

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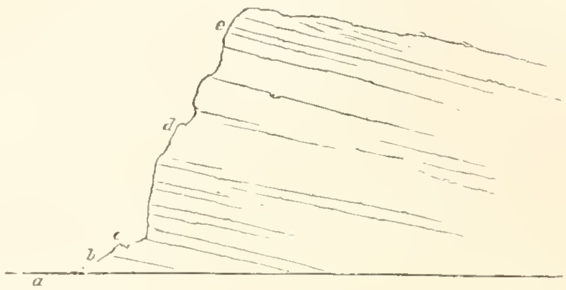
* See Report of 1840, by T. A. Conrad, p. 201.

The greatest thickness which I have been able to give to the Trenton limestone, is four hundred feet. At Chazy, where it is made up of alternating beds of limestone and shale, this, according to the best estimate I can make, is the thickness of this rock. The grey variety is, however, wholly wanting at this locality; if that is to be considered as a distinct mass, the whole thickness may be greater than I have given it. But at Watertown, where both varieties exist, the thickness cannot much exceed the above estimate. At Glen's Falls, it is much less; for, taking in a part of the calciferous and the black marble stratum, with

41.



the Trenton, the whole is not over sixty feet, the three masses of which form the bank of the Hudson river below the bridge, as is exhibited in the diagram above, No. 41: *a*, river; *b*, calciferous sandrock; *c*, drab-colored layers, with fucoides; *d*, beds of black marble; *e*, Trenton limestone, interlaminated with black shale. The upper layers of limestone have, however, been carried away; and hence the thickness is less than usual in the Mohawk and Hudson valleys.

6. Utica Slate.

Lithological differences between the Utica slate and the Calcareous shales of the Trenton limestone. — Differences of opinion in regard to the position of the rocks above this limestone. — Thickness.

The Trenton limestone terminates usually in a black shaly mass, variable in thickness, and in which we find many of the characteristic bivalves of the calcareous rock beneath; but the univalves have entirely disappeared, and do not pass into the shale. This is the first change which appears to have taken place towards the close of the period of the Trenton limestone.

The slate which bears the name at the head of this article, succeeds the Trenton shale, but scarcely differs lithologically from it: it is, however, firmer; exhibits a double system of natural joints, and is very constantly traversed by seams of satin or calcareous spar. It is, however, more certainly distinguished by attention to its fossils, in which there may be said to be an entire change; of the bivalves, scarcely an Orthis, Leptæna, or Atrypa is to be found. The orthoceratites of the Utica slate are unknown in the lower rocks, and so are the Crustacea. The Isotelus and Calymene, so abundant in the Trenton limestone and slate, do

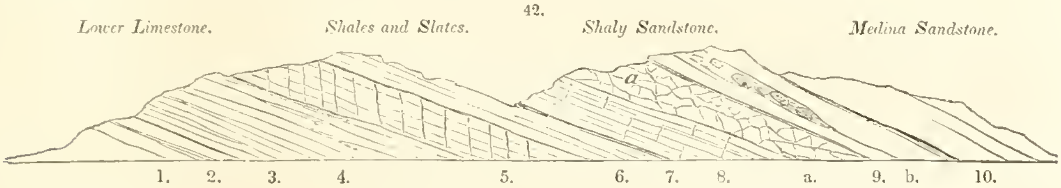
not seem to have survived the changes which took place between the deposition of one rock and the other; though, judging from an inspection of the two masses, nothing worthy of notice can be observed, which indicates a material difference in their composition, or in the circumstances attending their deposition; still, such is the change that the beings which flourished in great numbers during the Trenton era, are apparently swept out of existence, and their places supplied by new forms, a few new genera, or new species.

In general, there is a scarcity of fossils in the rock under consideration; the actual number of individuals of the species which are found in it, are much less than in either of the rocks below. The change, therefore, from one rock to another, is remarkable, and must have been produced by causes acting generally, for the above facts are found to prevail wherever the rocks have received a careful examination.

The characteristic fossil of the Utica slate, is the Triarthus beckii, a remarkable crustacean, which appears to be confined wholly to this mass. I have neither seen it in the Trenton slate below, nor in the Lorrain shales which overlie it; yet it is constantly present in this rock, having found it in the shales above Glen's Falls, at many places in the valley of the Mohawk, and at the Falls of Montmorenci.

Much confusion existed in relation to the geological position of this and the succeeding slates and shales, not only in this country, but in Europe; they had uniformly been placed below the limestones described in the preceding pages, and adjacent to and immediately upon the primitive rocks. Such, in fact, appears to be the order along the western face of the Green Mountain or Taconic range; but leaving this point for remark hereafter, I would observe, that the Utica slate may be examined to advantage in the Second District, at or near Glen's Falls, or along either shore of Lake Champlain, or to still greater advantage in the gorges in Lorrain and Rodman in Jefferson county. The annexed section is introduced in this place, for the purpose of exhibiting distinctly not only the geological position of the Utica slate, but the whole of the upper series of the Champlain group:

42.



1. Chazy limestone; 5. Utica slate; a. Calcareous breccia;
2. Birdseye; 6. Lorrain shales; 9. Grey sandstone and conglomerate;
3. Marble of Isle La Motte; 7. Red and purple shales; b. Thin beds of limestone;
4. Trenton limestone; 8. Glazed slates; 10. Medina sandstone and marly sandstone.

The Utica slate weathers ash grey, and rapidly disintegrates; and where it is exposed in cliffs, frost and other agents constantly break it into small shivery fragments, which collect at the base in the form of a talus. When once dried, after being removed from the bed, it becomes firmer and stronger; but if immersed afterwards in water, it immediately breaks into numerous fragments. It is partly to this effect of water upon the mass, that so few fossils

are recognized in the great quantities of broken slate which are often found at the base of a cliff. There are no beds of roofing slate in this mass: every layer seems disposed to break as above described. From a cursory examination of the system of the natural joints, they do not appear to be confined to certain fixed directions. It is divided into crystalline forms, which are those of prisms whose angles respectively are 120° and 60°. But we often find other prisms, whose angles differ materially from the preceding; and from a great number of observations, I have found it difficult to determine which system of natural joints predominates.

The rock to which the Utica Slate is equivalent in the Silurian System.

Though the fossils which are given as characteristic of the Llandeilo flags have not yet been discovered in the Utica slate, yet I believe it is a member of this formation. This opinion, I confess, is founded upon the similarity of the lithological characters of the two rocks, which I well know is rarely conclusive. There is, however, something in rocks, their structure, mineral veins, arrangement of parts, etc. which may often be employed in identifying strata, and which have proved of great value. So far as these may be relied upon, they go to support the opinion I have expressed.

Thickness.—The Utica slate, in the gorges of Lorrain and Rodman, is about seventy-five feet thick: it is, at least, less than one hundred feet. Here we may determine this point with great accuracy, though it may be, and probably is, thicker elsewhere. In all the disturbed localities, it is extremely difficult to arrive at even an approximation of its thickness, or scarcely to identify it very satisfactorily, as the disturbances to which it has been subjected have materially altered it. Hence its recognition is difficult, especially when it is associated, or in juxtaposition with shales of the succeeding rock.

43.

From a Sketch by E. EMMONS, Junior ; *showing the structure and appearance of the Lorrain Shales, at Lorrain, Jefferson county.*

7. LORRAIN SHALES.

Lithological characters.— Condition as it regards fossils.— Gorges at Lorrain and Rodman, etc.

In the Annual Reports, this mass has been designated, *Pulaski Shales*, a name which it would have been well to have retained, if it had embraced the whole series ; but at Pulaski only the upper part is visible ; while at Lorrain, the entire mass is exposed and cut through by the Sandy creek, from the grey sandstone to the Trenton limestone. Lorrain is, therefore, a locality far more important than Pulaski ; and hence, according to the modern practice of giving names to rocks, the former is to be preferred to the latter.

The Lorrain shales, as they exist in Jefferson county, may be described as consisting of thin beds of grey sandstone, alternating with fine argillaceous slates of a greenish color.

They are quite even-bedded, with few or no contortions produced by disturbances subsequent to consolidation; but the sandy shales are uniformly composed of undulating lamina, produced probably by unequal accumulations of detrital matter. The entire mass has a slight dip to the southwest, though to the eye it appears nearly horizontal. The sandstone layers are from four to eight inches thick; and the materials of which they are composed, are always fine, and never a conglomerate or breccia, so far as they are disclosed in the gorges of Lorrain or Pinckney. They become a brown or yellowish brown, by exposure to the weather, but are not acted upon very rapidly. The argillaceous shales are disposed to disintegrate; and where they form thick beds, are changed by the weather, both disintegrating and decomposing, so that the natural walls are falling and breaking down by the pressure of the superincumbent rock. This process is greatly aided by the presence of sulphuret of iron in many places; so that in a thickness of twenty feet, the shale becomes a black powdery mass for a depth of several feet, the whole of which has the styptic taste of sulphate of alumine and sulphate of iron; those salts being formed first by the decomposition of the sulphuret of iron, and secondly the action of the free sulphuric acid on the alumine of the rock, and the iron, one of the elements of the pyrites.

The upper parts of the Lorrain shales are highly fossiliferous, but this condition gradually diminishes, so that in the central portion of the rock, only a few fossils are to be found; but they are not entirely absent, and what is important to state, is, that some which are abundant in the upper part, are sparingly found in the lower also. Thus, the Pterinea carinata is found at Lorrain within six feet of the mass or rock denominated *Utica slate*, where it contains its characteristic fossil, the Triarthus beckii. This being the fact, it seems to indicate the propriety of preserving entire the whole mass under one name; and not, as has been proposed, separate the upper from the lower, and make thereby two rocks instead of one. It is certainly no uncommon thing for a rock to be non-fossiliferous in the lower part, and highly fossiliferous in the upper; and so far from the fact proving the propriety of making a separation in these cases, it rather goes to show that a separation ought not to be made, especially where the lithological characters are uniform throughout the rock.

Towards the upper part, the Lorrain shales contain a single layer eight inches thick, which is close-grained and nearly compact, and also quite extensive, being present in the cliffs in Rodman and Pinckney as well as at Lorrain, places which are separated ten or twelve miles from each other. It has a very close resemblance to the carbonate of iron of the coal formation; and at one place the whole layer has that curious structure denominated *cone within cone*. No fossils are found in this layer, though they are abundant beneath and above it.

Another stratum worthy of particular notice, is calcareous, but so meagre and poor, that it is no where sufficiently charged with lime as to be worth burning; but it is made up almost entirely of fossils, cemented by argillaceous and siliceous matter. It is rarely more than twelve inches thick; yet it is remarkably persistent, and is found to occupy one position in all the gorges of Lorrain, Rodman and Pinckney. It also forms a prominent stratum at Pulaski, and at the several localities where this rock is disclosed in the neighborhood of Rome.

The Lorrain shales, then, as they exist in Jefferson county, consist of thin, even-bedded

layers of sandstone and argillaceous matter alternating with each other, the latter often extremely fine, and the former never coarse: mica in minute scales is common in many layers, but is not apparent in all. The materials of this formation are quite subject to disintegration; and hence, wherever streams have passed over it, they have, in process of time, worn in the rock a deep channel or gorge. In the towns of Lorrain, Pinckney and Rodman, the surface is so much channelled by the streams, that a free communication between them is prevented, except by circuitous routes. These gorges will be particularly noticed, when I come to speak of the geology of Jefferson county.

Thus far I have been particular in giving the characters of the Lorrain shales and sandstones, as they exist in Jefferson county. When, however, we extend our examination to distant fields where the same formation prevails, we find a greater diversity of mineral character, and that the whole series is not fully represented by the rocks I have just described.

By reference to section No. 42, it will be observed that several masses, differing mineralogically from each other, are represented as occupying a position superior to the Utica slate. In addition to those strata which have been observed in the gorges of Lorrain and Rodman, the following must be considered as belonging to the formation:

1. *Deep red and purple shales*, the former fine grained, and without scales of mica; the latter coarse, and containing mica, approaching a fine grained sandstone. They rarely contain seams of spar, or any imbedded mineral substance.

The position of this variety appears to be inferior to the shales peculiar to Lorrain: at least, I have not been able to discover them in Jefferson, or the adjacent counties. We find this mass occupying a narrow belt of the shales, which passes through the higher parts of Columbia, Rensselaer and Washington counties, and onward through Vermont into Canada. It is every where destitute of fossils. It is fine, but sharp-gritted, and is often employed for houses. It is durable, and resists the action of weather, and does not split in thin lamina on being wet.

2. *Glazed slates.*—The mass is composed of flattened ovoid pieces, but made up of lamina which separate readily from each other, and which always leave a fine black glossy surface, as if it had been covered with a black japan varnish. It is often mistaken for coal.

So far as I am able to judge, this variety does not occupy a distinct place in the series, but appears to have been produced from the shales by certain movements in and of the mass. It is not purely argillaceous, but contains hard siliceous or calcareous particles, which were separated from the aluminous matter while in a soft plastic state: these, therefore, became the centres of attraction, and formed small ovoid nuclei, which, when the whole was subjected to an elevatory movement, produced friction and pressure, so as to give a polish and compactness to all those points where the resistance was unequal. This mass is always in a shivery state; and it is impossible to discover traces which mark, even obscurely, the probable planes of deposition. Neither are their joints produced by crystallization, as in most shales; the planes, therefore, of deposition, and the natural joints, appear to have been destroyed, or broken by a double movement to which the mass has been subjected. The first was un-

doubtedly chemical, and consisted in the separation of the siliceous and calcareous particles from the general mass, and of their segregation into central points of attraction. If, under these circumstances, an impulsive or mechanical movement was given to it, those centres of attraction, composed of siliceous or calcareous matter, could not but be obliged to move on each other; and the softer coating which surrounded, or in which they were enveloped, would necessarily be pressed and compacted about the harder, which would probably result in the formation of polished, but flattened masses.

3. *Of calcareous shales.*—They effervesce briskly with acids; they consist, therefore, of calcareous and argillaceous matter intimately mingled, and probably in about equal proportions, though they are more shaly than calcareous to the eye. They are fine-grained, and destitute of lustre, but sometimes contain glistening scales of mica. Seams of quartz and calcareous spar traverse the beds in many directions. Geodes, containing crystals of quartz and lime, are common; or what is more frequent, the spar is in crystals, either in acute rhomboids or dodecahedral prisms.

The color of this mass is bluish grey, with a texture very uniform. It is massive, and does not split into flag-stone, and the pieces of the rock are quite angular. It is a durable stone, and only slightly affected by the weather. Most of the shales and sandstones at Lorrain become yellowish brown by exposure; and in this particular, there is a sensible difference.

In this mass, I never have been able to discover fossils, except some obscure markings similar to fucoids. The materials composing it appear to have accumulated rapidly, which might have interfered with the due performance of the functions of life. The thickness of this mass is about sixty feet.

4. *Of thin beds of limestone,* always fine-grained and earthy, and variously checked with seams of calcareous spar.

These beds may be considered as way-boards, or layers which mark the direction of the planes of deposition. They are mostly impure, but sometimes may be employed for lime. They are, however, rarely more than one foot thick; and hence, under ordinary circumstances, the labor and expense of quarrying are too great to be profitable.

5. *Of beds of flinty slate,* with sharp cutting edges and conchoidal fracture; color green and bluish black; perfectly close-grained, or compact like flint or jasper.

The beds of flinty slate are often checked with seams of white or grey quartz, and sometimes with calcareous spar, and the surfaces covered with implanted crystals of lime, quartz and sulphuret of iron.

6 *Of calcareous breccia.*—The mass is made up of angular fragments of limestone and a slaty sandstone, between which there intervene seams of calcareous spar.

It is sometimes in beds from thirty to fifty feet thick; and so compacted together, and composed of so much calcareous matter, that it may be employed for marble, as at Swanton, Vermont; but as it occurs along the Hudson river, it is unfit for this purpose, in consequence of containing so much slate and dull earthy matter, and an imperfect incorporation of the materials.

This mass is remarkably persistant; though its average width is only about ten feet, yet it is found along the Hudson and Lake Champlain, for nearly two hundred miles. It becomes thicker at St. Albans and Swanton, Vermont, and is wrought as a marble, and burned into lime. It is traversed by seams of spar, which often cross the angular fragments of limestone or slate, or even a fossil, under circumstances which demonstrate that the seam was formed subsequent to the formation of the rock by cementation. The fossils are fragments of the Isotelus gigas, and bivalves belonging to the Trenton limestone. They are of a date anterior to the formation of the mass, and preëxisted in the fragments which compose it.

The quality of the marble is quite superior, in some respects, to that furnished by the ordinary limestones; but as its natural joints are obscure, or irregular, it is expensive to quarry; it being impossible to procure it, except in irregular shaped blocks, which are liable to become shaky, or shattered by the use of gunpowder in raising them from the quarry.

7. Grey Sandstone.

Termination of the Lorrain Shales in a Grey Sandstone, in which the number of fossils have diminished. — Characters. — Different masses which appear to belong to the same age. — Termination in a Grey Limestone.

The Champlain group terminates in a mass which, in Jefferson county, is an even-bedded grey sandstone, whose texture is rather fine than coarse. It is siliceous, but not vitreous. It can scarcely be called a micaceous sandstone, though it is not wanting in any of the layers. The thickness of the beds varies from four inches to two feet. It is colored by the slaty matter diffused through it, and frequently encloses a mass of slate which is similar to that in the Lorrain shales.

There are no good sections which disclose this rock in connection with the shales below: we see enough, however, to inform us of the changes which have taken place in passing from one formation to the other; they consist simply in a diminution of the green shaly matter, a thickening of the beds of sandstone, and the extinction of most of the forms of animal and vegetable life which are so abundant in the rock beneath.

This rock, in the section of country under consideration, is quite uniform in all its characters; and it has scarcely been disturbed in its position, or changed by the action of foreign agents, since its deposition. It agrees, therefore, in these respects, with the rocks upon which it rests; but in order to obtain a full account of the mass which belongs to the period immediately subsequent to the Lorrain shales, we are obliged to examine other sections of the State. Though the grey sandstone is much more even-bedded and finer in its materials, and more uniform in its structure, still it appears to be equivalent to what geologists have usually called *greywacke*, in the counties of Columbia, Rensselaer and Washington. The even-bedded fine-grained sandstones are not wanting in the ranges of hills through these counties, yet generally they are coarser, harder and more compacted, and consequently bear some resemblance to greenstone. It is, however, different in containing beds of breccia; and though

the particles of which it is composed are not large, yet they are united very firmly together by a green argillaceous cement, similar to chlorite, the matter of which was probably derived from the chloritic slate which forms the eastern boundary. From the same source, too, the hyaline quartz was derived; or at least it bears so strong a resemblance to the quartz of the talcose slates of the Taconic range, that it cannot be distinguished from them.

The differences in the sandstones of the two regions does not stop here. There are two additional facts to be stated:

1. The sandstone west of the Taconic range is often brown or reddish brown, especially in Vermont, on the eastern border of Lake Champlain, as at Addison, Charlotte, Burlington and Colchester; at all of which places, the beds of sandstone are interlaminated with a reddish shale.

2. The fact of the most importance, is the termination of the sandstone in a grey or white limestone, which may be seen at the places already named.

To complete the view of this rock, we must take into our description the mass of conglomerate at or near Utica, which I have no doubt is really a part and portion of the grey sandstone. It represents, it is true, the whole mass; and it is also true, that some geologists regard this as a superior rock. It rests, however, upon the Lorrain shales, and bears no distant resemblance to the conglomerate belonging to the greywacke.

If the preceding views are correct, the masses belonging to the *grey sandstone* may be enumerated as follows:

1. A greenish, fine-grained, even-bedded sandstone, with thin green slaty layers interposed, and sometimes inclosed also in the rock.

This variety prevails in Jefferson county; its territory is limited, and it is found better developed in the county of Oneida, south of the Second Geological District. It is employed for flags, grindstones, etc. and constitutes an excellent material for building. A few fossils are found in the lower part of it, but none which differ from those in the formation beneath.

2. A reddish brown, or chocolate-colored sandstone, whose layers vary in thickness from four inches to two feet, and alternate with thin laminated shales of the same complexion.

This variety does not exist in the counties assigned me; it is, however, the predominating sandstone on the eastern shore of Lake Champlain. It is crystalline, or breaks into rhombic masses. Quarries of this rock do not work kindly; neither are the layers readily shaped, and they are hard, approaching to vitreous. Thickness about seventy feet.

3. White, grey and reddish limestone, terminating downwards in the preceding rock. Its beds are always thick, and the whole rock is massive, and checked by seams of spar and quartz.

This limestone is always impure, or siliceous, in the lower part, but becomes purer towards the top of the mass; it also loses its tinge of brown, and becomes white. It is often a pure white limestone, but its particles are always fine; or, in other words, it never becomes the saccharine limestone of the Taconic system. It is the limestone at Bald mountain, which

has so long furnished the lime for the cities of Troy and Albany, and the villages to the north. This rock, though it is high in the Transition system, contains no fossils of any description.

4. A greenish breccia, whose fragments are not coarse, but very strongly compacted or cemented together. Its coloring matter appears often to be chloritic; and when the mass is fine, it has a trappean appearance.

This variety is rather to be regarded as existing in beds, or inclosed in the sandstone. It is the typical *greywacke* of authors. It resists disintegration for a long time, and the beds are scarcely acted upon by the weather, which neither softens nor discolors the mass. Veins of spar and quartz traverse it in all directions, and hence it appears chequered, which, however, cannot be safely considered as identifying the rock. Like the limestone noticed above, it is entirely destitute of fossils.

The finer kinds of breccia, and coarse sandstone, when not too hard, form a very good building stone. They are extensively used in the construction of buildings, both public and private, and in the fortifications of Quebec. The thick massive beds have not been much employed in this State for construction, but the slaty varieties are extensively used for flagging.

5. A conglomerate, consisting of rounded pebbles of quartz, united apparently without the intervention of a cement.

This conglomerate is confined to Oneida county. It is a hard unyielding mass, and is much inferior, as a building material, to either of the preceding varieties. It is destitute of fossils.

Of this limestone, it is necessary to remark, that it resembles so nearly another limestone, or one which I now suppose belongs to a different period, that it is exceedingly difficult to distinguish them. The one I now speak of, certainly occupied the position which I have given it, above the grey sandstone ; but there is another in the primary of the Taconic range farther east, in the slates of which the range passing through Pownal in Vermont, and Williamstown, Pittsfield and Richmond in Massachusetts, are examples, which resembles it so strongly, that I have at times been disposed to consider the two as one and the same rock. This acknowledgment may not speak very well of my discriminating powers, yet I would shelter myself from the charge by stating some of the difficulties : 1st, neither rock contains fossils ; 2d, their lithological characters are not remarkably different ; 3d, they are both sometimes associated with slates, which also resemble each other ; and in the 4th place, they lie along a disturbed district. I hope, however, yet to clear up all the difficulties of the case : in fact, my mind is made up, but I am in want of some facts to satisfy others that my conjectures are right.

The limestones of Berkshire county have been fully and ably treated of by Profs. Dewey and Hitchcock ; but that which rests upon the rocks formerly denominated *greywacke*, has not been noticed at all in geological works, in a way which would enable inquirers to recognize it. I gave a diagram illustrative of its position, as well as of the rocks beneath, in the Report for 1838, but omitted the main facts relative to its distinctive characters.

This limestone is rarely a homogeneous mass ; but, as has been observed in almost all

places, it is remarkably traversed by seams and veins of calcareous spar and quartz. This is not, however, peculiar to this limestone, and hence those veins do not characterize it with sufficient precision ; and I may remark here, that it is necessary to look carefully to its superposition, in order to satisfy ourselves of the true nature of the mass, or in other words, whether it is a transition or a primary limestone.

The brief description of this limestone has been given, for the purpose of furnishing a full and complete view of all the rocks which are embraced in the Champlain group. It does not occur in the Second District in place, but ranges entirely through the valley of the lake which gives name to the group ; but is confined wholly to the Vermont side. In Jefferson county, where the upper portion of this group is tolerably well developed, this limestone is not to be found ; nor is it recognized in the Mohawk valley.

Thickness.—The whole thickness of the sandstone and limestone is not over one hundred feet, estimating it at those places where the least disturbance exists. Of the thickness of the whole group, it is not possible to arrive at certain conclusions ; but forming our estimate from the individual masses composing it, at those places where the least disturbance exists, or where the beds are nearly horizontal, it is not far from fifteen hundred feet. Going into the disturbed districts, however, those for instance east of the Hudson river, there is apparently an enormous thickness of the shales and sandstones composing the upper part of this group only. If we consider the mass between the Hudson and Massachusetts line as a succession of different strata, they must form together a thickness of twelve or fifteen miles. Such a view, however, I believe to be incorrect and unwarrantable ; and the probability is, that there is a succession of uplifts, so that there is a frequent recurrence of the same strata, instead of an uninterrupted succession of different beds. This view of the subject is not only favored by the number of long and nearly parallel valleys, but by the frequent appearance of a hard sandstone, which seems to be the equivalent of the grey sandstone and limestone already described, and which without question are the superior rocks of this group.

CHAPTER VI.

TERTIARY.

Name and lithological characters. — *Arrangement of the beds.* — *Fossils.* — *Era of the deposit.* — *Thickness.* — (See Plates I. II.)

The valley of Lake Champlain, and the basin of the River St. Lawrence, supports a formation composed of clay and sand, to which the name *tertiary* has been applied.

In employing simply the word *Tertiary*, in the place of *Post-Tertiary*, the designation which of late has been given to it, I am influenced by the conviction that no advantage can be derived by multiplying names where real differences do not exist, or where they are doubtful, or resolve themselves into mere shades of differences. Looking at the Tertiary of modern authors, as it is, and regarding it as a distinct formation from the Secondary, I can see no advantage in making a farther division of what must be admitted to be geologically a recent deposit, and the several divisions of which must belong to the modern era. The terms *Eocene*, *Meiocene* and *Pleiocene*, express fully all the subdivisions which can profitably be made in a formation where lines of demarkation do not really exist, and where they are liable to vary annually, and with the progress of discovery, and especially when there is really no fixed standard of comparison.

Who can suppose, on reflection, that *percentage* is a universal law; or that it can be established, except loosely, and subject to vary with the progress of discovery? It is true, that where there are gradations, we may make three terms, one of which will be a mean. But all our observations in geology go to prove that neither life, nor the extinction of life, has ever been regulated by rigid mathematics; that even the approximation, which may be found to prevail in a given region, may be departed from in another. Of the tertiary of Champlain, I can consider it only as the expression of the extreme term in the threefold division of the distinguished author, Charles Lyell, that it is the *Pleiocène*, or the full developement or dawn of the present. To separate, therefore, the last term of the threefold division, will rather mar the beauty and break the order which is established, without bringing with it any advantage to the same.

The tertiary of Champlain is mineralogically composed, in the ascending order, of: 1st, a stiff blue clay; 2d, a yellowish brown clay; and 3d, of yellowish brown sand. The three portions into which the formation is here divided is, however, of little importance, inasmuch as the upper part of the clay owes its color principally to weathering, rather than to any important difference in its composition. The whole contains a sufficient amount of carbonate of lime to effervesce briskly with acids, though there appears to be less in the inferior, than in the superior part. Sand begins to appear in the yellowish clay, and increases gradually until it predominates, and finally becomes a pure siliceous sand.

This formation, as it appears along the shores of Lake Champlain and the St. Lawrence river, is not calculated to excite much attention; consisting, as it generally does, of beds of clay, without fossils, or any thing peculiar to attract attention. It is only where the observer happens to meet with those portions of it which are fossiliferous, that his interest will be much excited. Of the fossils which have been observed, there are about twenty species in all. They are, however, very unequally disseminated, and there are only a few localities which contain numerous species. The two species generally contained in the formation, are the Saxicava rugosa and Tellina grœnlandica. In most places along the shore of the lake. and of the St. Lawrence river, these two fossils may be found on careful inspection. They are in an unmineralized state, rarely filled with clay. In addition to the two species of Mollusca I have just mentioned, the following I have discovered as existing principally at two places, viz. at Port Kent, and Beauport near Quebec: Tritonium anglicum, Tritonium fornicatum, Mytilus edulis, Pecten islandicus, Mya truncata, M. arenaria, Tellina, (two species,) Turritella, Nucula portlandica, Bulla, etc. (See Plates I. and II.)

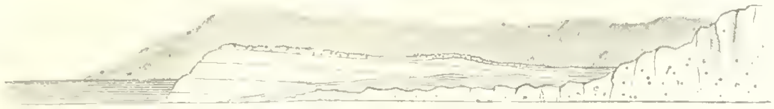
Denudations which this mass has suffered since its deposition.

As has been stated above, the formation in general does not present any striking characters by which it would excite particularly the attention of the geologist, except at a very few points; and it is at those points that it appears highly charged with fossils. Now we may inquire the cause of this remarkable circumstance. It is true that molluscous animals are found congregated at places which are the best adapted to their organization; and the inquiry might arise, whether it was owing to causes connected with structure and function, that so few localities are to be found where those remains are deposited; or whether they may not have been drifted into their present position?

In answer to these questions, I remark, that the whole deposit bears evidence of having been formed under quiet and undisturbed waters, and that the entire formation consists of clay, sandy clay and sand; and that it is in the mixture of clay and sand, or towards the upper portion of the formation, that the remains principally exist: where, therefore, a mere bed of clay is found, we have no fossils. Again, the fact that they preserve their markings and edges entire, and valves in place, though many are exceedingly frail, forbids the idea

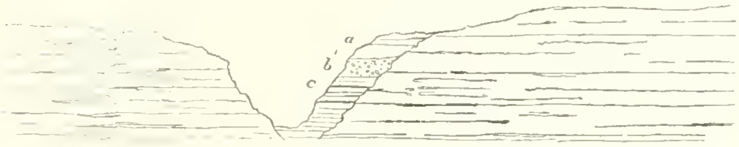
that they could have been drifted into their present position. The result, then, appears to be, that the greater part of the upper portion of the tertiary has been swept away; for it is only in sheltered places that the whole formation exists entire. At Port Kent, it is protected by Trembleau point; and at Beauport, by a deep ravine. Thus, (fig. 44,) the formation lies

44.



north of the point, which rises up immediately at the south, protecting it thereby from the abrading action of currents of water. At Beauport, the mass of tertiary, containing an enormous quantity of shells, is deposited in a narrow gorge one hundred feet deep, through which the Beauport river flows, a section of which is given in the annexed diagram, fig. 45.

45.



a, Saxicavas. *b*, Pectens, Myas, &c. *c*, Blue clay.

The lower part of the formation is composed of a stiff blue clay, without fossils. Approaching the upper part, we find it embracing a few pectens, tellinas, myas and terebratulas, all of which are perfect, without injuries from abrasion; even the delicate terebratula is perfect, both hinges being in the natural position. Amidst this lower mass of shells, there are numerous water-worn boulders, beneath which the fossils lie uninjured; but, had they all been brought together in the form of drift, they would have exhibited evidence thereof, in the crushed state of the shells; but as it is, and as they are, all appearances go to prove that the whole were deposited in quiet waters while the animals were living, with the probability that they were destroyed by an uplift of the country, which raised them above the waters in which they were quietly performing their functions.

The upper part, at Beauport, is composed almost entirely of the Saxicava rugosa; and they form a bleached white mass, twelve feet thick, perfectly stratified, and with only sufficient sandy matter to form the lines of division between the strata.

Thickness.—Under favorable circumstances, the tertiary of Lake Champlain accumulated to the thickness of about one hundred feet. As it exists, however, on this lake, it is rarely over fifteen feet thick; though at Burlington, it forms an exception, where it is probably between ninety and one hundred feet. We are liable to be deceived, however, in this parti-

cular, when the formation was deposited upon the sloping sides of the shores adjacent to the sea; for though it might extend upward two or three hundred feet above the floor of the formation, yet it would be no indication of the depth or thickness of the mass. It is rarely disturbed by fractures or faults: a few, however, exist, but the derangements are slight, and it is extremely rare to meet with contortions; and the stratification is parallel, with scarcely a deviation from a horizontal position.

Extent of the Tertiary of Lake Champlain.

There is rarely in geology a fact more interesting than the one which relates to the wide extension of this formation. Commencing at Whitehall at the head of Lake Champlain, it may be traced continuously not only the entire length of the lake, but also to Quebec, and as it also appears, far towards the Gulf of St. Lawrence. It also lines the shores of the St. Lawrence river as far as Ogdensburgh. From Whitehall south, clay beds, whose characters conform perfectly with those upon the lake, extend indefinitely. In Albany county it becomes an important mass, and there is great probability that it is contemporaneous with the tertiary of Lake Champlain, though as yet fossils have not been discovered in it to complete its identity; it is, however, to be remembered, that a large part of the clay upon Lake Champlain is also destitute of fossils, and here the dissimilarity is not so great as at first may appear. Indications of the same formation exist upon the shores of New-Jersey, the Saxicava rugosa having been found in a condition resembling those upon Lake Champlain. On the eastern Atlantic, too, this formation shows itself still more unequivocally, particularly at Lubec in Maine.

This formation appears, therefore, to be extended widely, particularly in the north where it is best characterized; but we have not yet reached its utmost bounds. From the information derived from the works of Lyell and other distinguished European geologists, we have every reason to be satisfied that it exists in Sweden, particularly at Uddervalla, where the same fossils occur as at Port Kent and Beauport.

All the facts relating to this formation point to a period, by no means ancient, when the northern parts of Europe and America were submerged; from which condition it has been elevated by forces which acted not only widely, but in power remarkably uniform.

My attention was first directed to this formation in 1835, while on a visit to Lubec in Maine; and a few facts noticed at this visit were published in the Journal of Science for that year.

I have now noticed some of the most important facts relating to this mass; there are, however, many inferences of great interest, which are to be drawn from its position, and the relations which it has to the phenomena of drift and diluvial action in this country, which will call for particular attention hereafter.

The fact then that the fossils of the tertiary are limited to the upper portion, has tended to obscure the characters of some clays which are widely distributed, principally in consequence

of the denudation which they have suffered ; for like the non-fossiliferous slates, lithological characters are quite insufficient for their designation. The clay to which particular reference is made, is that which is known as the *Albany clay*, or that which lines the shores of the Hudson for a long distance, and which in fact is connected to, or continuous with, the clays of the valley of Champlain. But as this formation, the moment it leaves the valley of the lake, furnishes no fossils, it becomes, when considered by itself, an enigmatical mass ; connected, however, as it evidently is, with the tertiary of Champlain, its characters and age are at once brought out, and we learn for the first time that it is one of the most recent of our marine formations. Other facts throw an interest over it, which is wanting in other cases, even the more extensive ; they are those connected with the period and circumstances under which it was deposited : first, it succeeded the period when the rocks of the valley of Champlain were grooved and scored, a period which may have been stormy, unsettled and fluctuating. To this succeeded a period of repose, when the argillaceous matter of this formation was quietly deposited, the lower portions of which formed rapidly from the great abundance of this matter in its waters, so much so as to prevent the existence of even molluscous animals. After a while, the turbidness so far diminished that animals became inhabitants of the waters, a period marked by the appearance of sand. These animals were rapidly extending themselves in different directions, when suddenly the whole region was uplifted and raised above the sea. During this period, boulders were evidently transported either by shore ice, or on icebergs, and were frequently deposited in the midst of the beds and congregations of these living animals, but did not at all interfere with their existence. Thus, at Beauport near Quebec, small water-worn rocks are found in the midst of the fossils, and in numerous places single boulders are dug out of this clay in the process of excavation for the purposes in which it is employed, though they are by no means numerous. It has, however, been observed by some geologists, that there is often a mass of drift beneath the tertiary. I have not, however, seen those localities cited in proof, but have been disposed to regard them as belonging to another mass, and not as beneath the true tertiary of Lake Champlain ; they belong rather to the drift, in which beds of clay may often be found holding a position above a mass of drifted rocks and stones. Such masses are very common in the primary and mountainous districts of New-England ; they are always insulated, and never continuous but for a limited extent. They are found reposing on the sides of hills, and in the valleys ; and the boulders in them are very numerous, and they contain but a small proportion of carbonate of lime.

I have stated that the upper portion of the tertiary has been removed ; and that in carrying away its fossils, the currents which swept over it removed also the criteria by which to judge of its age, and of the medium in which it was deposited, whether of marine or of lacustrine origin. In the place occupied by this removed portion, we often find the latest drift. Some difference of opinion, however, has been expressed in relation to this, viz. that it has not been transported by a forcible current, but is the result of slow transportation from neighboring hills. Now, if there were not clear evidences of a rapid abrasion of the upper part of this

formation, this explanation might be more probable ; but those sands have been carried up several hundred feet in the ravines of the mountains of the north ; terraces at a lower level have also been formed extensively of this sand alone ; and frequently the boulders have been carried along and deposited in the midst of it, indicating at least the probability that the same rush of waters which denuded the tertiary, bore along also the loose rocks and other coarse materials then upon the surface, and deposited them at a distance far to the south. It is, however, unquestionably true, that there is a slow and gradual transportation of loose materials from the higher to the lower levels, and that the mass assumes the form of terraces, and lies along the base of all the ancient hills ; they may be distinguished from the transported matter, as consisting of the debris of the hills and mountains directly above, and never containing those which belong to a distant section of the country.

Facts in relation to this formation have been accumulating for many years. In 1835, I examined a deposit of marly clay of the same age as that of Champlain, in the vicinity of Lubec in Maine. I found that all its fossils were marine, and that they all belonged to species now living in the Atlantic, and some of which were species which have been found in the tertiary of Champlain. This was elevated only twenty-five or thirty feet above high water. This same formation occurs at numerous places along the coast.

The valley of Champlain, and the St. Lawrence, however, furnish the most important deposits in this country. It is in fact continuous, though confined to a narrow belt, from the head of Lake Champlain to the Gulf of St. Lawrence, and probably, admitting the clays of the Hudson to be of the same age, to the Atlantic on the south. It also appears on the River St. Lawrence at Ogdensburgh, in which there are saxicavas and tellinas, though few in comparison with the same species on Lake Champlain.

From these facts, it will be seen that the formation extends far and wide. It is not, however, thick at any place ; rarely appearing more than fifty feet, and upon the shore of Lake Champlain rarely more than twenty feet. Apparently, it is one hundred feet at a few localities upon the eastern or Vermont side of the lake. The thickness of the mass is not to be confounded with the height at which the formation is found above the lake ; in this particular, I have already remarked in another place, that it occurs three hundred feet above its present level.

An important fact not to be omitted under this head, is, that though this tertiary is comparatively thin, yet its limits are not confined to this country ; it is found in the north of Europe, distinctly characterized, particularly at Uddervalla in Sweden. Those shells in particular are mentioned by Mr. Lyell as abounding at this place, which are also equally abundant at Beauport, viz. the Saxicava rugosa, Natica clausa, and Pecten islandicus. During the last summer, this distinguished geologist visited several of the localities of the Champlain tertiary, which has confirmed the views he had before entertained in relation to the identity of this formation with that at Uddervalla. This is an interesting and important coincidence ; one which establishes a similarity in the condition of the two continents at the era of its deposit, as well as in regard to the changes which both have since undergone.

Geological reasoning founded upon the tertiary under consideration.

From an examination of the shells of this formation, Mr. Lyell has expressed the opinion that the climate of Canada, as well as that of the north of Europe, has undergone a considerable change since the period of its deposition; that it was colder at that time than at present, a deduction founded upon the existence of animals now inhabiting a more northern latitude, or which are now indigenous to a colder climate, and also to the limited number of species compared with those now inhabiting the sea in the same latitude. Without calling in question the correctness of Mr. Lyell's opinions, I would inquire whether the limited number of species may not be accounted for on other grounds? Viewing the whole formation not only as quite recent, but as having been formed in a period comparatively short, may we not infer that sufficient time was wanting to extend and increase the number of species in the estuaries and along the shores, as they then existed? As I have already remarked, the mass is thin; and it appears from examination, that no molluscous animals are found in the stiff blue clays which constitute at least two-thirds of the whole formation. Animals, therefore, did not appear at all in it till towards the close of the period when it was forming, or the materials accumulating; the period, then, during which they existed, was short, and probably insufficient to people a wider extent of territory; those species which had established themselves, increased at some favorable points exceedingly, but the number of species increased but slowly, and only as the condition of the sea became better fitted for their increase, and more favorable to their habits; all those portions which are now inland were upheaved, and became dry land very soon after this state of things was established. To favor this view, we may remark that there was undoubtedly a submergence of the country over which the tertiary is now found, and that for a long period previous it had existed as dry land. The conditions which would follow such a change or submergence, would be, as has elsewhere been stated, a muddy state of the waters ill suited to the habits of the mollusca which are now found in the tertiary. The result which I wish to arrive at, is simply this, that if time had been given, molluscous animals would have been as numerous at this period in these particular localities we have in view, as at any upon our present seacoast. In the list of fossils already given as belonging to the tertiary of Champlain and Uddervalla, there are really but few which do not exist upon the coasts of Massachusetts and Maine. By far the greater part are the inhabitants of a temperate climate.

Upon the subject and question of change in climate and condition of the globe, I have never been able to find evidence of those extremes which are often taught in our books on geology, and particularly by our popular lecturers. Placing great confidence in the principles taught by Mr. Lyell, I have been led to look with a degree of skepticism upon those doctrines which come tinctured with the wonders of the past; the astounding changes and revolutions which have taken place in the planet; the heat and burning of a tropical sun in the latitude of forty-five; and those glaciers encrusting half of the northern hemisphere, thousands of feet in thickness, followed by the sudden and rapid fusion of the whole, and deluging continents

with their mighty waters. The earth has had its stormy periods, without doubt; life has often been at the mercy of an agitated tumultuous ocean; the earth has rocked with earthquakes. mountains have been upheaved from the deep, long lines of coasts have been reclaimed from the ocean's sway; living beings have had their allotted times of existence, and have ceased to exist; but all this has been but the still small voice, when compared with the tremendous convulsions taught by modern geologists. We must look at the past and present as belonging to one system, and to all the changes which have taken place as limited in degree and extent. The Lingula which existed at the era of the Potsdam sandstone, was fitted by its structure to exist now, for aught we can know to the contrary. The waters and air are as compatible to the existence of the Ichthyosaurus and Mastodon now, as in the era of the lias, or the period preceding the flood.

The wonders of sober truth ought to be sufficient to satisfy the boldest minds, and to gratify the imaginations of the cultivators and lovers of positive knowledge, without seeking to magnify and distort the operations of nature, and to assimilate them to the dreams of an agitated and sickly mind.

The above remarks have no reference to the limitation of animated existences, for we know of no limitation which shall compass the forms of living beings; truth treads closely upon the wonderful and extravagant; and we realize in nature, both in the past and present, what to the untaught and unobserving would pass for the picturing dreams of a half wakeful condition. One sees that the possibilities of existence has no limit, though nature constructs and builds up her forms from models of the simplest kind, and often appears to husband her resources; yet often do we meet her under forms and conditions so extraordinary that we have feared we should charge her with extravagance if we received and admitted only the truth, or believed what our eyes were permitted to see. These views by no means conflict with the preceding. The physical world is adapted to living beings; these adaptations are strictly limited, and will not permit of wide deviations from a certain standard under the present system upon which beings are organized. The extremes of heat and cold are within narrow bounds to the unprotected; the atmosphere above and the waters beneath, can suffer but little change before it strikes a death blow to the organization of every being within their media.

We may be assured that it is the will of nature to preserve and protect the races, till their destiny is completed; and we may reasonably doubt the teachings of geologists when they would have us believe that whole races have been extirpated at once. Individuals suffer, but the race may live on, till the powers of organization are too enfeebled to continue their kind, or to wage a longer warfare with the elements.

CHAPTER VII.

TACONIC SYSTEM.

It has been deemed advisable to annex to the general account of the group of rocks of the northern district, a brief sketch of the series which constitute the *Taconic System*. By reference to the preceding pages, it will be perceived that they do not appear in the Second Geological District; but inasmuch as some of the most important and interesting relations of the Champlain group could not be understood without a knowledge of this series, I propose to describe them in this place. This determination is, however, in accordance with my original design, viz. to furnish a full account of the rocks up to the grey sandstone, the highest and last member in the Champlain group. In taxing myself thus, I have been influenced by the desire to furnish the materials necessary for a complete work on the New-York rocks, as far as my district, and its connection with those adjacent, is concerned; and to make this volume as distinct from, and independent of, the reports of the other districts, as the nature of the subject and its relations would permit. The fulfilment of this task requires the work which I have now undertaken.

These remarks are made in part as a general apology for stepping over the bounds of the Second district, and out of the limits of the field which was originally assigned me; and particularly to the geologist of the First district, within whose bounds this system of rocks is fully developed. But that the propriety of this course may be more clearly understood, I remark farther, that it is only in the Second district that the lower members of the New-York system are fully developed. In the First, they are much disturbed, and the relations are obscure; in the Third, which extends to the primary north of the Mohawk valley, there are several members wanting, and some whose character, if taken alone, are insufficient to entitle them to the appellation of distinct masses; while in the Fourth district, the series commences with the Medina sandstone. It will be perceived, therefore, that my design is to furnish a full account of the rocks which are in any way connected or related to the lowest group of the New-York system; and as the materials or facts are derived both from a series which are undisturbed and those which are dislocated, and as I have reason to suppose also are more complete than in any other portion of the State or Union, they must form the only basis of a satisfactory description, as it is the only field where all the members are distinctly developed,

and where all the relations of the lower masses can be observed. To leave, therefore, a group or system of rocks which belong evidently to a position between the primary of the Atlantic ranges of mountains, and the New-York system, would have left a chasm unfilled, a work incomplete in itself. In these remarks, the writer does not expect to be able to give full justice to the subject on which he is about entering; the merit, to a certain extent, of removing some of the obscurities which envelope this system of rocks, is all that he would claim, together with the fact of having placed it in a new light before the American public.

The Taconic system, as its name is intended to indicate, lies along both sides of the Taconic range of mountains, whose direction is nearly north and south, or for a great distance parallel with the boundary line between the States of New-York, Connecticut, Massachusetts and Vermont. The counties through which the Taconic rocks pass, are Westchester, Columbia, Rensselaer and Washington; and after passing out of the State, they are found stretching through the whole length of Vermont, and into Canada as far north as Quebec. It is, however, in Massachusetts, in the county of Berkshire, that we find the most satisfactory exhibition of these rocks. They form a belt whose width is not far from fifteen miles along the whole western border, and which extends clearly to the western base of the Taconic range. The greatest breadth, therefore, as will be seen by an inspection of any map of this section of country, is wider upon the eastern than upon the western side of this range. In Vermont, they range along the upper members of the Champlain group, and thus become connected with the Second district.

Persons who have contributed to our knowledge of the Taconic rocks.

By reference to the early numbers of the Journal of Science, it will be seen that Profs. Dewey and Hitchcock early turned their attention to the rocks under consideration. The former, distinguished for his scientific attainments, gave an elaborate essay, wherein the rocks were described as fully as was possible in the infancy of geology in this country; in fact, so far as mere description is concerned, very little remains to be added.

In 1829, the History of Berkshire was published, the matter of which was contributed by the clergymen of the several parishes in the county. In this work an abridgment of Prof. Dewey's former essay appeared, so that a general account of these rocks has been widely circulated. Prof. Hitchcock has at various times furnished many important facts in regard to the geology of Berkshire, but, as appears from his publications, has relied mainly upon the information derived from Prof. Dewey's labors, especially in his elaborate and excellent work on the rocks of Massachusetts. To these gentlemen, therefore, we are principally indebted for the facts which have been placed before the public.

It will be observed, however, that it is many years since those publications were made, or rather since the observations were made which form the basis of all the accounts which have appeared. We have then an additional reason for making a reëxamination of the masses which compose this system of rocks; for it is to be expected that an application of the principles of geology as now established, will somewhat modify our views in relation to them.

It is expected that the progress of science will do this, especially that of one whose advancement has been rapid and unimpeded for the last twenty-five years in this country.

Position and Relation of the Taconic System.

The position of this system of rocks deserves an attentive examination; for it is only by a clear understanding of their position, that we shall be able to explain some of the remarkable phenomena found in connection with them. Turning our attention first to the eastern border, we find the primary ranges of New-England, at elevations it is true not very remarkable, but still above the adjacent country upon the west. It is to be noticed, too, that the western slope is rather steep; and it may be considered that it is against this steep slope that the Taconic system reposes. There is one exception, however, to this statement, viz. Saddle mountain rises more than a thousand feet higher than Hoosic mountain. Upon the west is the Taconic range, pursuing its course near the western border of the system, and attaining an elevation of eighteen hundred or two thousand feet. A large portion, then, of its rocks or masses are interlocked between these ranges: the New-England or primary ranges upon the east, the most important of which is the Hoosic mountain; and the Taconic with the more westerly abrupt hills upon the west, or the eastern border of the New-York Transition system. It is this position which is to be taken into view, when we attempt to account for the numerous contortions which exist in the beds lying between these mountains; and there are many facts which favor the view that the rocks lying in this narrow space have been greatly compressed by lateral pressure, and have been forced, as it were, towards the Hoosic mountain range.

The preceding view is favored by the fact, that in the midst of the most mountainous tract, the greatest contortions exist; while in the more level parts, or sections, the contortions and disturbed strata are greatly diminished. In this connection, I may state another result as the consequence of the geographical position of the Taconic system: it is the partial blending of the rocks of the three adjacent systems; the Primary of the Hoosic ranges upon the east, and the New-York Transition system on the west with the Taconic; creating thereby many doubts and perplexities as it regards the true limits of either system; and inasmuch as the whole belt itself of the latter rocks is narrow, doubts are thrown over the whole as it regards the views we are to take of them. It will be more clearly seen in the following pages, how it is that differences of opinions prevail in relation to these rocks. Where they have been crowded together, and especially where the masses are lithologically similar, it is not at all remarkable that the views and opinions of geologists should differ; besides, under the most favorable circumstances, the lines of demarkation between rocks of different eras are often extremely obscured, and cannot be drawn with that exactitude we wish, in consequence of concealment under the soil, or other circumstances equally effective to render their extent and relations indistinct and uncertain.

Taconic System not connected with or related to the Slates and Shales of the Champlain Group.

Much difficulty is encountered, as has already been hinted, when we attempt to draw the line of demarkation between the shales and slates east of the Hudson river and Lake Champlain, and the slates of the Taconic system. So nearly do the latter resemble the former in lithological characters, that in specimens of small size, the one might be mistaken for the other. But this is a common difficulty, or one common to all rocks of the same lithological characters, and it is not to be considered as a positive objection to the separation which I now propose.

There are two or three other points it may be well to state in this place: One is in regard to the condition of the country along the line of junction of these, and of almost all other rocks; there is, for example, a concealment of the strata by rocks and earth for quite a wide space, covering the termination of the masses on either side; added to this difficulty is the confusion created by the great sameness in the direction of dip; and as both are lithologically slates or shales, and both liable to certain changes in their planes of stratification and of deposition, a wide door is opened through which we may run into mistakes and create confusion. In fact, it often happens that where either of these difficulties exist alone, special care has to be taken to avoid error; but where they all appear, as in the instance under consideration, we can scarcely expéct to escape falling into some gross mistake — that especially which concerns the designation of the rock.

But I have, at the head of this section, asserted that the slates and masses of the Taconic system are not related to, or connected with, those of the Champlain group. By this I mean that they are not the same rocks in another condition; or, in other words, they are not a part of the former group in a metamorphic state. This is proved by the want of conformity in all essential characters, particularly the want of similarity in position of those rocks which agree in chemical constitution. We do not expect that by any agent a slate can be changed into a limestone, or is likely to be; neither will the order of superposition in the series be changed by metamorphism. Hence, in rocks suspected to be metamorphic, it is necessary to ascertain the order of the masses; and if the order corresponds, and there is a gradual change from one to the other, it is possible that one of the masses is metamorphic; but if there is no correspondence in the position of the masses composing the group, then we have no right to call in the aid of the metamorphic theory to prove that the rocks belong to one group or era. Thus, in the limestones of the Taconic system, we have no correspondence in position with either of the limestones of the Champlain group. The granular quartz, too, if it is equivalent to any mass in this group, it is to the Potsdam sandstone; but it lies between masses of limestone, and is in the form of great beds unconnected with each other. It is, therefore, the want of similarity in the position of the masses with the rocks lying west, etc. which they resemble sometimes so closely, that leads me to reject the idea that the rocks of the Taconic system are merely metamorphic rocks or altered masses of the Champlain group. But if this

question is settled satisfactorily, may not the Taconic rocks be considered as simply the primary, and varieties merely of the talcose slates, primary limestone, etc.? This question is one of equal importance with the preceding, and requires an attentive examination; and its decision requires the establishment or admission of two or three doctrines or principles, which have not been fully sanctioned by geologists, or recognized as authoritative.

In fossiliferous rocks, geologists are agreed to regard organic remains as paramount to all other characters, where the order of superposition cannot be determined by inspection. We find, however, no fossils in the rocks of which I am speaking, and hence can derive no aid from that source, upon which any reliance can be placed; and besides, the peculiar position in which they are placed adds difficulties to those already enumerated. But it is confidently believed that there are characters which, though they may not give us that kind of information which fossils do, yet are capable of being employed as distinguishing marks. Those characters may be reduced to two principal kinds: 1st, the lithological characters of the rocks themselves, and which is the usual view taken of them; and 2d, the imbedded or associated minerals. As a general rule, certain minerals are found in particular rocks; and may not a similar rule or law prevail where a system of rocks is concerned?

But leaving this question for the present, I remark, that comparing the several members of the Taconic system with rocks bearing the same name in the Primary, very little doubt remains of their total dissimilarity. Comparing the slaty rocks of the former with the latter, we find a broad line of distinction drawn between them; taking, for example, the so called *talcose slates* of the two systems, I have no hesitation in saying that constant and reliable differences exist, and may be found in all careful and close examinations. These differences exist in the quality of the slates themselves, particularly in the color and lustre of the laminæ, and their peculiar contortions. But more decided differences are found in the associations of the rocks: the talcose slate of the Primary system is universally associated with hornblende or soapstone, or both; while the talcose slate of the Taconic system is never associated or connected with either of those rocks; or, to state the fact in other words, never passes into them, whereas in the former case it does. Another fact of the same nature is also well determined by observation, viz. that the imbedded minerals belonging to each rock are remarkably distinct. Actinolite, epidote, titanium, auriferous sulphuret of iron, etc. are never found in the Taconic system. I might go on and state other particulars, or facts whose bearing is the same, but this I deem unnecessary in this place.

This brings us to the conclusion, then, that where the associated minerals are different, the rocks themselves are different; and there are so few exceptions to this statement, that it appears to the writer to furnish sufficient grounds for separating one system from the other, by the aid of characters sufficiently important and decisive for all the purposes of geology.

I have confined my remarks to the differences in the slates; equally important are they, when we compare the limestones of the other systems with those of the Taconic. While the texture and grain of the limestones of the two systems differ, there are still more distinctive and specific marks which may be employed: the presence of graphite in the limestones of the Primary system may always be depended upon, even in hand specimens; for not an in-

stance has occurred in which this substance has appeared in the limestone of the Taconic system, or in an aqueous deposit. Besides, the instances are not very numerous in which any minerals of the primary rocks are found in this system. White pyroxene and tremolite do occur at a few localities; but the peculiar constitution of graphite makes it very doubtful whether it is even produced in rocks of aqueous origin, except where they have been subjected to the powerful action of melted lavas, or to the influence of caloric in some other mode. Molecular action, unaided by heat, is insufficient to effect the decomposition of carbonate of lime, so far as the development of carbon from carbonic acid is concerned; and then its combination with metallic iron, to complete the chemical constitution of this substance, appears to be still more difficult. Wherever graphite exists, we may rest satisfied with the conclusion that the agency of caloric has been there, and in a state too of great intensity.

If then reliance can be placed upon lithological characters, and upon associated minerals, we may raise something more than doubt as it regards the identity of the Taconic rocks with the true Primary system, or certain members of it. In truth, much confidence is felt in the correctness of the principles which have influenced me in proposing their separation, and that they possess characters fully sufficient to give them an independent place in the systems of the day.

Error has often arisen, in not making the distinctions here insisted upon; or it has been more easily fallen into, by the frequent proximity of the two kinds of limestone to each other, and their near approach to identity, where mere texture and crystallization is concerned. Thus, along the Hoosic mountain range, we often find the true Primary limestone very near the Stockbridge limestone; and both being often dolomitic, and of a coarse texture, and more than this, composed of *carbonate of lime*, it is a sufficient reason why the two should be regarded not only as one mineral, but one rock. But I trust that in the preceding part of this report, I have already said enough to place this subject in its true light: the reader is accordingly referred to pp. 37–67.

After what has been said of the slate and limestones of this system, I deem it unnecessary to speak of the general characters of the granular quartz rock, which occurs in mountain masses in the same system. It is sufficient to observe, that in position, it does not correspond to any of the sandstones or siliceous rocks of the New-York system, and cannot therefore be regarded as a metamorphic rock; for example, an altered mass of the Potsdam sandstone.

If the preceding views are admissible, there is sufficient reason for regarding the rocks which lie between the upper members of the Champlain group and the Hoosic mountain, as a distinct series at least; but I would remark, that by the expression, "lying between," I have reference to geograpical position; for considered geologically, they can be regarded in no other light than as inferior to the Potsdam sandstone, or as having been deposited at an era earlier than the lowest member of the New-York Transition system. We have in no instance, however, been able to trace a connection in these masses, and we have never found the Potsdam sandstone resting upon any of the members of the Taconic system. To attempt to explain this remarkable feature, or fact, would be premature. The bare fact that the Potsdam sandstone rests on gneiss or granite, without the interposition of any other rock, we early pointed out; and commencing our series with it, we find it to be unbroken and unin-

terrupted up to the Old redsandstone. But if we commence an examination at the foot of the Hoosic mountain, which is gneiss, we pass over a series totally different from those of which we have just been speaking, and among which the Potsdam sandstone does not appear, neither a limestone which can be referred to those of the Champlain group, or slate or shale which can be recognized as belonging to the New-York system. If we are correct in this conclusion; if the Taconic rocks differ as much as has been represented from the Primary, and also from the Transition series, then it appears necessary that we should adopt views at least somewhat analogous to those expressed in the preceding pages.

Much that is useful in the discrimination of rocks, may be learned from the mode in which minerals are connected with them. As we do not expect to find tourmaline, garnet or staurotide in an aqueous deposit, so when they do occur in their appropriate rocks, they have a uniform connection with them; they belong to the mass, and are contemporaneous with it; it is rare that any cavities appear around them, but they are closely invested on all sides by the materials of which the rock is composed. On the contrary, in aqueous rocks, minerals occur in preëxisting cavities, and they are usually composed of substances more or less soluble under one or more conditions.

In the Taconic system, there are two or three instances in which minerals do occur as in the Primary rocks; thus, octahedral magnetic iron appears in the magnesian slates, and extremely fine needle-form schorl in a siliceous slate. A few instances of this kind, however, ought not to overthrow the views here expressed; they may serve to weaken, but they are to be set over against numerous instances which have a contrary bearing. We are to remember that these rocks belong to the earliest deposits; that they have been exposed to agencies which, if not of a different character, were yet more intense than those at present in operation; or that they have been exposed to molecular action aided by caloric, which must result in a new arrangement of the particles of which they are composed.

General Strike and Dip.

Confining the observations to the Taconic range, that portion especially adjacent to the eastern borders of Columbia, Rensselaer and Washington counties, and the western part of Berkshire in Massachusetts, I have found the strike to vary from 10° W. of N. to 10° E. of N. If we direct our attention to the country one hundred and fifty or two hundred miles distant, we shall find but little variation of the strike from a north and south direction. The variation, therefore, seems to be quite local, and will be found confined to short distances. The several rocks which have been enumerated coincide also in the direction of their strike, thereby affording evidence of their belonging to but one system.

The dip is very uniformly east, sometimes steeply so, but averaging only 30° or 55°. It is proper to remark, that the dip of the Primary rocks upon the east have apparently the same direction, but it is really much greater; a fact which shows that there is no passage of the Taconic rocks beneath the Primary. This dip is regarded as a remarkable fact, and one which, in the view of some geologists, required a complicated movement; a movement

which resulted sometimes in the complete overturning of the strata. At present, I am disposed to regard the matter in a more simple point of view, viz. as nothing more than uplifts, which, in consequence of the confined position of the rocks, have often produced local foldings or plications of the strata. These foldings appear mostly in the valleys.

Liability to mistake the limestones of this system for those which lie adjacent.

Owing to the remarkable position of the Taconic rocks, there is some danger of confounding the limestone on the one hand with those of the Primary, and on the other with the Transition rocks. Within comparatively a narrow belt there are four limestones, whose characters are so nearly alike that they are often mistaken for each other, or not distinguished at all: 1st, in the ascending order, is the true Primary limestone with graphite, lying closely along the border of the Stockbridge limestone; 2d, the Stockbridge, which being often sparry, and of a fine texture, is mistaken for the true sparry limestone, or if coarse, for primary; 3d, the latter ranges along in proximity to a limestone which replaces in part the grey sandstone of the Champlain group.

These four limestones being destitute of fossils, and not being very diverse in character, but no more variable than is usual, are easily misunderstood, unless we first bear in mind their real existence, and note carefully their position. The limestone of the upper part of the Champlain group is often quite siliceous, somewhat sparry, but is never regularly or evenly bedded; and if the mass below is revealed, it will be found to be a reddish or grey sandstone. The sparry limestone is quite even-bedded, of a grey color, very sparry, and is underlaid by a fine argillaceous slate. The Stockbridge limestone is granular, white or clouded, and occasionally sparry, and either lies in the magnesian slate, or sometimes the granular quartz appears on one side; it is, however, always found in connection with marble, and I believe neither of the other limestones furnish this material. The Primary limestone is always unstratified, and is in connection with hornblende, gneiss, granite, or some rock which is unquestionably primitive. Bearing in mind, therefore, the existence of these four limestones, the order in which they lie with regard to each other, and the associated rocks, most of the difficulty of distinguishing them will vanish. It is not to be understood that those limestones form all of these continuous masses; the oldest and the most recent are extremely irregular in their appearance, while the remaining two will be found more constant than most rocks.

Difficulties in distinguishing the slates of the Taconic system.—Analogous to the limestones spoken of above, are the slates of these rocks, and there are four liable to be mistaken for each other: 1. The true talcose slate, associated with gneiss, hornblende, steatite or serpentine. 2. The magnesian slates, also talcose, and not improperly considered as a *talcose slate;* its associations and connections are with granular stratified limestones and granular quartz; no hornblende, serpentine or steatite appears in connection; a fact which has, however, been before stated. 3. A fine aluminous slate, beneath the sparry limestone. This slate appears in close proximity with the shales and slates of the Hudson river, making the fourth mass as

stated above. Varieties of these two often resemble each other; their connection, however, furnishes means for distinguishing them; besides fossils are not unfrequent in the latter, even in the denuded strata, but more have been met with in the former.

I have now stated what appears to be essential in discriminating correctly the limestones and slates of the systems of rocks which lie in such close proximity to each other. I believe them to exist in nature, and worthy of consideration.

CHAPTER VIII.

Rocks composing the Taconic system; order of superposition; general strike and dip.—Liability to mistake some of the slates and limestones for those which belong to other systems.

The number of rocks which compose the Taconic system is quite limited; this is an important feature, which is not to be lost sight of. It does not, however, follow that it is necessarily thin; on the contrary, it is remarkably thick, and hence becomes of more importance than appears from a simple statement of the number of rocks of which it is composed.

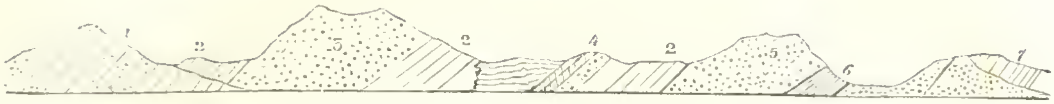
As a whole, we find granular quartz, slate and limestone to form the entire system. But it is to be remarked, that it is necessary to take cognizance of two kinds of slate and two of limestone; for although there are many points of resemblance in each of the two rocks respectively, still their position and lithological differences, though small, require their separation. The full enumeration is as follows:

1. A coarse granular limestone of various colors, which I have demoninated *Stockbridge limestone*, taking its name from a well-known locality, one which has furnished to different parts of the Union a large proportion of the white and clouded marbles which have been so extensively employed for building and other purposes in construction.
2. *Granular quartz* rock, generally fine-grained, in firm tough crystalline masses of a brown color, but sometimes white, granular and friable.
3. *Slate*, which for distinction I have denominated *Magnesian slate*, from its containing magnesia, a fact which is distinctly indicated by the soft feel peculiar to rocks when this earth forms a constituent part.
4. *Sparry limestone*, generally known as the sparry limerock.
5. A slate, which I have named *Taconic slate*, and which is found at the western base of the Taconic range. It lies adjacent to the Lorrain or Hudson river shales, some varieties of which it resembles. In composition, it contains more alumine and less magnesia than the magnesian slates.

In addition to the above rocks, there is sometimes a slate of a dark color, and quite siliceous, in the granular quartz. This appears less constant, and may be considered as a slaty quartz, or variety of this rock. There are several deposits, important in themselves, which strictly belong to this system: the hematitic iron ores, associated sometimes with carbonate of iron, and the black oxide of manganese. Subordinate to the rocks, we find milky quartz and chlorite, with carbonate and oxide of iron in the magnesian slate.

The following section, extending from Petersbugh, Rensselaer county, to Adams in Massachusetts, embraces all the rocks in this system. Its direction is nearly east and west, or perpendicular to the strike of the system over which it passes:

46.



1. Gneiss.
2. First bed of limestone.
3. Magnesian slate.
2. Second bed or Stockbridge limestone.
4. Granular quartz.
2. Third bed of limestone.
7. Shales of the Champlain group.
5. Second mass of magnesian slate.
6. Sparry limestone.
8. Taconic slate.

The preceding section is intended to exhibit not only the rocks and their relative position, but also to illustrate my views in regard to their dip, and other phenomena which are brought to light in this system of rocks. While it is admitted that there are many obscurities which cannot be fully removed, and which with our present knowledge must remain, still it appears that the simplest illustration leaves fewer objections than those which suppose a complicated series of movements. With this view of the subject, I have adopted a mode of explanation which is as far removed from complexity as possible, and to which there could be no objection, were it not assumed that the rocks of the western edge of the Taconic belt are newer than those of the eastern, or in other words, at the time of their deposition rested upon the eastern; but if dip is an indication of age and superposition, the fact is directly the reverse. Leaving the further consideration of this subject for another place, I will barely remark, that my object in presenting these views, is to elicit facts from other observers; that by careful study in the field, we may be enabled soon to clear up all those points which are now so perplexing.

Turning once more to the preceding section, it is apparent, if the section is true to nature, that an easterly dip may have been given by several successive uplifts, or by the force which occasioned those uplifts. This force, if regarded as general, and as operating beneath the primary, we may consider that it might have upheaved the Hoosic mountain range, giving its masses the easterly dip; and as it was applied or exerted beneath those of the Taconic system, gave to its rocks also a similar inclination; and still passing onwards to the west, produced derangements of the strata of the same kind in the masses composing the Champlain group, the effects of which are more particularly seen in the Hudson river slates and shales. That this force acted beneath the primary, is rendered probable by the exposure of the gneiss, bearing up this series of rocks on one side without deranging them; while on the other, the same rocks are thrown down, leaning against the gneiss at a high angle. But we have, besides the dip, other phenomena to explain; the occasional folding of the strata, or double contortions. We can conceive of but two methods by which changes of this nature, or folding of the strata, can be produced; one of which is, a force applied beneath, whose general effect is to uplift the strata, but which at the same time exerts a lateral force, which bends or flexes them upon each other at the moment the masses are under movement; the

second is, the cooling of the great internal mass, by which change the external coat becomes too large, and then in adapting itself to a diminished circumference, presses the strata laterally, so as to produce folds and wrinkles. Of the two views, preference is given to the first, inasmuch as we have evidence that the phenomena of which I am speaking seem to have taken place subsequent to the creation of animals, and of course after the refrigeration of the planet had reached its present state, or nearly so; for there are reasons for the opinion that it was not till after the deposition of the New-York system that the derangements occurred, and which is particularly indicated by the direction of the uplifts and fractures in the Champlain group, being parallel with those of the Taconic and Primary systems, and hence, according to the views of distinguished geologists, occurred in the same era, if not at the same time. Whatever may be the opinions on this point, it so happens that the direction of the uplifts and fractures in the Primary, Taconic and New-York systems, are parallel, in those belts which are immediately adjacent to each other. There is, it is true, an uplift with a fracture, commencing near the western edge of the Taconic rocks, which runs up the valley of the Mohawk, and which of course deviates considerably from parallelism with those which run up the valley of the Hudson and Champlain. This appears to be an exception to what has been stated, but the majority by far of the fractures are parallel with those valleys; besides, the era of that which produced the valley of the Mohawk, is probably much later. Before these important questions can be settled satisfactorily, much labor in the field will be required. Our country is so wide, the points for examination so numerous, and the whole field so extended, that some time must yet elapse before our doubts can be solved, and confidence given to our speculations.

There appears to be one point established by the phenomena of the rocks under consideration: it is that sameness of dip and sameness in lithological characters, as well as other points, may happen to two or more systems; which leads me to remark, that where there are resemblances of these kinds, we need not, for those reasons only, consider the rocks as at all produced in the same era, or as belonging to one system; for we know by observation, that the same force which commences its action in an older system, may be extended to the newer, and produce analogous effects. In most of those cases where similar derangements are produced, we find the more marked effects at or near the junction of two rocks or systems, which unquestionably arises from the thinness of the strata: a fact, too, which requires to be taken into the account in estimating the thickness of a mass; for along the exposed edges of fractures, we may very probably ask ourselves if the same mass does not increase its thickness towards the central part of its bed, or the deeper part of the basin in which it was deposited? However this may be, we often find, along the line of junction between different masses, numerous fractures and uplifts, by which complicated derangements appear, and which create many difficult points of inquiry that require an extended series of observation for solution.

A question arises, whether the limestones which appear occupying distinct belts may not in fact belong to one single bed, which was brought up by so many successive uplifts. Thus, at the west base of the Taconic range, there is the sparry limestone; passing over this range to the east base, we find a bed also differing somewhat in lithological characters; and passing

still farther east across the valley of the Hoosic in Williamstown, Mass., to the foot of Saddle mountain, there is another; and again at the base of the Hoosic mountain is another still, which is the most easterly of all. Now it is a question whether these several belts of limestone may not belong to one bed; it is at least worthy of attentive examination. It is, however, a question which I have often sought to solve, but I have not yet succeeded in a way which is satisfactory to my mind; but I have concluded to regard them as distinct, inasmuch as there are differences of some importance, particularly in thickness, and a want of correspondence in the beds themselves. There appear to be at least three distinct ranges: 1st, The belt at the foot of the Hoosic mountain; 2d, The one at the base of Saddle mountain, and which spreads through the valley of Williamstown; and 3d, The belt at the western base of the Taconic range. These belts appear to pursue nearly parallel courses, and never to commingle.

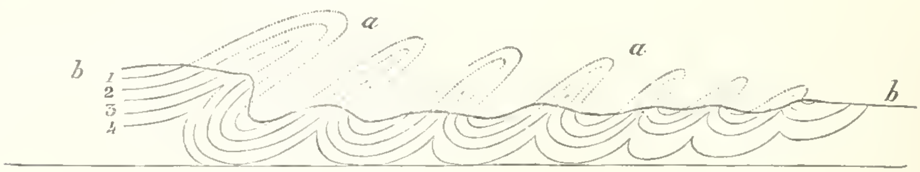
There is still another vexatious question; it is in relation to age. It has been customary to regard the limestone along the base of Hoosic mountain, or the most easterly belt, as the oldest; and that at the western base of the Taconic range, the newest. Viewing them in this light, we are perplexed at once in consequence of their dip; for the most westerly dip, as has been repeatedly observed, beneath the most easterly, or that which has been considered the oldest mass. Now if questions of this kind are to be settled by appearances, that is, by coarseness of grain or texture, or by what we deem *primary aspect*, then perhaps the decision is right; but I do not know that we have any right to this assumption. The primary aspect is sometimes borne by rocks of modern origin; and in neither case can we decide the question by proximity to any other system, that is, we have little reason for saying, that because the eastern belt lies along the primary, it must therefore be older than the western, which lies along the fossiliferous rocks of the New-York system. The truth is, we do not know the position of the basin in which these rocks were deposited, to enable us to decide at this late day which is the older, or which the newer side of the basin, except it be from the dip of the rocks. There seems to be no valid reason against the opinion that the most western belt of limestone is, after all, the oldest of the Taconic limestones. All being destitute of fossils, we must judge of age by their relative position, or by superposition; and so long as the most western belt by this rule is the inferior limestone, I can see no necessity in the case to suppose a series of complicated changes in order to make it coincide with our conjectures.

If we direct our attention for a moment to the views of other geologists, particularly to those entertained by Profs. Hitchcock and Rodgers, the reader will be able to compare both with his own observations. Viewing, as these gentlemen do, the Taconic rocks as metamorphic, and as really an eastern prolongation of the members of the Champlain group, their peculiar dip, together with their other relations, are explained on the supposition of their being thrown into a series of folds or plications by lateral pressure, each fold producing an elevated range of rocks or mountain ridges, with a steepness much greater on the side most distant from the great mass of primary, than upon the side towards it. The curvatures or plications, together with the varied steepness, is represented in the following figure:

47.

The folds or contortions represented in the figure are of course somewhat distorted, but they are the supposed forms which the strata are made to assume when subjected to lateral pressure; rising up on one side in a gradual slope, while on the other the descent is sudden and rapid. Folds and plications on a small scale, of the same character, exist at numerous places in the disturbed shales of Lorrain, as well as in the slates of the Taconic system, in which all the curvatures are preserved. When, however, we look for them in our mountain masses, it is rare to find them. If they exist at all, they must of course appear under the modified form represented in fig. 48, in which the greater portions of the curvatures are

48.



broken off in the line *b b*, which will represent the present surface; the long and gentle slope on the eastern side would be still preserved, as well as the steeper and more abrupt one of the western declivity. As it regards the difference in the steepness of the two sides of the mountain ranges, the fact, as here stated, holds good in some places; in others, it does not: it depends upon the direction of the dip; if that is to the east, the long and gentle slope is upon the east side; on the contrary, when the dip is to the west, the steep side looks to the east. In this particular, the case is apparently precisely as in all others; on the fractured side of the strata we get steepness, a result which may, and often does result from an uplift accompanied with a fracture. The two diagrams which I have introduced to illustrate the theory of curvatures, seem also to show the relative position which they preserve when thrown into contortions; they exhibit, too, the fact that strata may apparently dip beneath themselves, by tracing those marked 1, 2, 3, 4 respectively: it is, however, plain, as has been already stated in the preceding pages, that where strata exist under this form, they cannot dip into the mountain and form a part of the interior. The diagrams also are intended to show how the lower rocks of New-York may be prolonged to the east, when being near the primary mass; and having besides been subjected to great pressure, their features and characters as fossiliferous rocks are concealed under their metamorphic dress. In this view, I have given my

reasons already for presuming to dissent; but I may go on and remark farther and more in detail, at the expense of some repetition.

It is not so much the object of these remarks to express doubts in regard to the existence of similar plications: they often do exist, sometimes upon a small, at others upon a large scale; but in this arrangement, the relative position of the several masses remains unchanged. The granular quartz, for example, if deposited originally beneath limestone, cannot really be placed upon it, though the circumstances may favor an apparent dip beneath it. An inspection of the real position of the Stockbridge limestone, as shown in a true section, will satisfy most observers that the theory of plication is insufficient to explain one or two important points, particularly as it regards the position of the granular quartz or limestone with an east dip. No force or plication could have placed this limestone in the slate, embraced as it is on each side; and I take the opportunity to remark here, that it cannot correspond to either limestone in the New-York system, the Trenton, or Calciferous; for I hold it to be an absurdity, that by any metamorphosis, a sandstone can be changed into a slaty rock. The Potsdam sandstone being the lowest rock in the series, and being succeeded also by limestones, and these followed by a succession of slates and shales, we are unable to discover in the Taconic rocks a series at all analogous to those composing the lower members of the New-York system; and the folds and plications, though they may exist, by no means furnish a satisfactory answer to the fact of a change in relative position; that is, it does not appear that the limestones of one system correspond at all to the limestones of the other — the same remark holding good, too, in regard to the slates and sandstones.

These remarks are intended to disprove the unity of the Taconic rocks and the inferior members of the New-York system, differing from each other principally in condition, and which difference arises from metamorphism; not that the rocks may not be metamorphic in one sense of the word, that is, altered in texture since their deposition, but that they are not the members of the Champlain group, thus changed by internal heat or by any other agent.

CHAPTER IX.

Individual rocks composing the Taconic system; their characters; absence of fossils. — Mineral products. — Conclusion.

The order in which the Taconic rocks lie being unsettled, or at least not being so clearly established as is desirable, I am not particularly anxious to follow the usual order in the description of the individual masses composing this system. I shall therefore commence with the most western mass of slate, which I have denominated *Taconic slate.*

This rock is extremely fine grained, with delicate inelastic laminæ, and only slightly coherent; or in other words, the laminæ are separated easily from each other, especially where the rock is near the surface. The color is dark, passing into light blue, and often stained brown by decomposed sulphuret of iron. Small masses of quartz are often enclosed between the laminæ of slate. A waved or slightly wrinkled state of the laminæ is commonly exhibited, attended with a pearly lustre, and often with a reddish brown color. No organic remains have, however, been found in the rock; it is even destitute of those obscure markings which are called *fucoids.* Although then it has a general resemblance to the magnesian slate, which forms the greatest part if not the whole of the Taconic mountain, it is not so coarse, contains less quartz, and rarely if any chlorite. It is not, however, possible to describe this mass with sufficient precision to identify it without regard to its position. It may be said to lie between the Hudson river rocks on the west, and the sparry limestone on the east: it is undoubtedly overlapped by the former rocks, and it passes beneath the latter under a dip of 30° or 35°. The line of junction with the slates upon the west is exceedingly obscure, and I am not aware that it has been observed. On the east, however, the junction of the slate with the limestone is clear and distinct. It may be observed two or three miles east of Hoosic corners, on the Bennington road, near the hematitic ore bed. The layers of the slate and limestone alternate several times with each other, before the limestone finally prevails. I have not been able to make even an approximate estimate of the thickness of this slate: towards the western edge, the rock is concealed beneath debris of stones and soil.

This rock holds a definite position in the series, and may be traced very clearly for one hundred and fifty to two hundred miles, without any variation of character. Its strike varies but little from a north and south course, and may be traced by drawing lines near to, and parallel with the New-York State line upon the east. The rock, immediately upon its

western limits, is often a coarse greywacke, but this is not always the case ; and when the finer varieties of greywacke slate lie adjacent, it is very difficult to distinguish them from each other. So far as discoveries have been made, this rock contains no roofing slate : it appears too tender, its surface is too uneven, and it contains too great a proportion of quartz, sulphuret of iron, etc. to be employed for economical purposes.

1. Sparry Limestone.

Succeeding to the slate is the rock with the above designation, which I have employed in place of *Sparry limerock*. This name would be as useful as it is significant, provided there were not other limestones with occasionally sparry veins : as it is, it will not necessarily lead to error in the field, though it might in the cabinet.

The color of this rock is unformly grey ; it weathers unevenly, by which a rough surface is formed, disclosing in its composition silex and other earthy matter. It contains, besides, masses of quartz which traverse the rock in an irregular manner, and numerous veins of white calcareous spar which give it a chequered appearance. It dips to the east at the line of junction with the slate ; but after passing farther east, the dip is changed to southwest, where it rises into moderate hills whose steepest slope is upon the east side.

To recognize the characters of this rock, is a matter not at all difficult in the field : its curiously chequered surface, formed by a milk-white calcareous spar branching out upon a grey ground, will, it is conceived, be sufficient to create in the mind an image of the rock, and to impress upon it one of its most characteristic features. This rock is sufficiently pure to be used for quicklime ; and accordingly, along the belt of country which it traverses, it is often burned for that purpose. When it is sound, and can be obtained in suitable masses free from flaws, it would form a handsome veined and clouded marble. I do not know that it has been employed for this purpose.

This limestone is called *Transition limestone* upon the geological map constructed by Prof. Dewey for illustrating the geology of Berkshire county, Mass. It forms a long belt which stretches through the eastern tier of townships in Rensselaer and Columbia counties, as Hillsdale, Canaan, Lebanon, Berlin, Petersburgh, Hoosic, and onwards in the same range through Washington county into Vermont. On the Hudson river, it appears at Barnegat, where it is extensively burned into lime. Like all the rocks of the Taconic system, it extends a great distance north and south, while it is comparatively narrow. As it crosses the range from Petersburgh to Hoosic, the direction is disturbed, and it becomes more difficult to trace clearly its progress north. About two miles east of Hoosic, the range appears nearly in the direction of its former strike ; but it spreads out much wider in Bennington, Vt., than it generally does at the south ; though it is not impossible that the Stockbridge limestone may also appear upon its eastern side, and cause some difficulty in determining the true boundaries of the sparry limestone.

A subject worthy of attention, is the period of the formation of the veins of calcareous spar. From observations upon other rocks, which contain fossils, which of course are free from

calcareous veins at the time of their enclosure in the materials of the rock, it seems to be established that those veins were formed subsequent to the consolidation of the rock ; for it is not an uncommon circumstance to discover a shell traversed by a vein of spar. The most rational explanation appears to be, that the rock in drying, or in the process of consolidating, cracked in every direction ; and into the fissures thus formed, pure calcareous matter was infiltrated in sufficient abundance to fill the open space thus produced in drying.

2. Magnesian Slate.

The almost endless varieties of rock which appear under the form denominated *slate*, occasion great perplexity, as well as a diversity of views as it regards their age, among geologists. This is particularly the case when the rock is destitute of fossils, and lies in a disturbed district, where its relations have been subjected to change.

The rock now under consideration, is one to which these remarks particularly apply. Having no trace of an organism, and having at the same time an aspect intermediate between a primary and a fossiliferous rock, we find it difficult to settle down upon opinions which we are satisfied with, and which we can consider as well grounded or founded in fact. We may, however, arrive at one or two important probable truths in relation to this rock and its associates, viz. that they may have belonged to the period just preceding that when the earth became a fit abode for animated beings. If this should be found a rational opinion, these rocks open an interesting field for study, as in them we have the representatives of an era in the earth's history, formed under conditions approaching those which were required for the well-being of man. The one immediately preceding this era must have been one of great disturbance to the crust of the earth, and that did not admit of the accumulation of large bodies of water. The succeeding era was one of more quiet, and which permitted the existence of water, but probably with an elevated temperature and high solvent powers ; and hence the rocks formed during this period approach in character to the great mass of the truly primary, are more crystalline, and are somewhat removed as a whole from the aqueous deposits of more modern periods. Whatever may be our views of these rocks, it seems they must coincide in part with the preceding. The inherent difficulty, however, attending the acquisition of truth, where the subject is so far removed from modern conditions, will ever cause a diversity of opinion in many particulars. This field is too theoretical for my object in view. I shall therefore proceed to describe very briefly this rock.

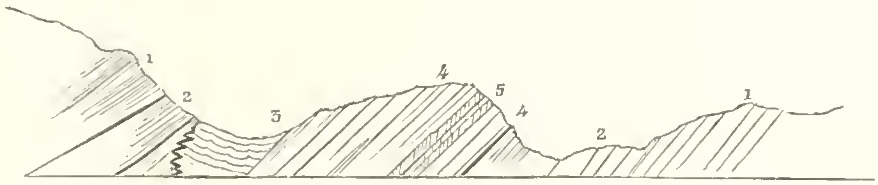
Some diversity of opinion prevails as regards the composition of the magnesian slate. Some geologists, and they are those from whom it is dangerous to differ, consider this as *mica slate*. For this reason I have sometimes been disposed to leave the description of this mass to other hands, being little inclined to offer opinions contrary to those who have also carefully investigated the subject. Still, circumstances have conspired to overcome these scruples, and to lead me along in the course I have taken in regard to them. Now, it requires but a very few words on the point whether this rock is a mica slate or not ; and I must observe, that failing to find any mica at all in the rock, I have come to the conclusion that it is not mica slate. In composition,

I believe it to be a variety of talcose slate ; and when the whole rock is taken into view, I conceive it to consist mostly of talc ; in addition to which, we have quartz, generally the milky variety, and chlorite, both in masses. Some diversity of composition is still to be found where the slate is in proximity to limestone, or the granular quartz. There is no great variety in this rock, however, whether we examine it on the borders of the sparry limestone along the New-York line, or along the edge of the Hoosic mountain range, almost in contact with gneiss. In this entire belt it is grey, light or dark, with a silvery or slightly pearly lustre ; the feel is never harsh or gritty, unless when near or enclosed in the granular quartz. Sometimes it is plumbaginous, or contains graphite in a fine state of subdivision, in sufficient quantity to soil the fingers; but it never occurs in crystalline scales, or in a state in which there is the least metallic lustre. It may be seen to differ in many respects from the talcose slate of the gneiss system ; being softer, and containing less silex, but it differs, as has been stated in the preceding pages, from the slates of the Primary system, by the absence of serpentine and hornblende.

There are a few minerals contained in this rock, which give it a primary character, viz. octahedral iron and needle-form schorl in crystals, which are disseminated in the rock in a mode similar to those in mica or talcose slate. These instances are, however, rare, and may not materially affect our opinions.

The section No. 49, exhibits the relations of this rock to the other members of the Taconic system :

49.



1. Slate of Saddle mountain. 2. Limestone of its base. 3. Granular quartz. 4. Magnesian slate. 5. Sparry limestone of Petersburgh, N. Y.

This rock, it will be seen, occurs in mountain masses, and is without doubt the most important member of this system. The same remarks are appropriate to this rock when its number of distinct belts are considered, as were made in relation to the limestone : that is, it is not easily determined whether there is more than one mass, or two, or three ; the appearance of it in separate and apparently distinct beds or belts, being the effect of as many different uplifts. There is probably two or more distinct masses, which, could we avail ourselves of the light which organic remains furnish, would enable us to determine the question with great truth and exactness.

This rock forms the great mass of the Taconic mountain. The sparry limestone plunges into it at its base ; and above, on the west side, the range rises in steep declivities. Along the summit, milky quartz abounds in irregular masses of every form ; they contain chlorite, and the oxide and carbonate of iron. Scarcely any change in mineral characters is ever found to have taken place. Traced from the Highlands of New-York, along the borders of the State,

into Vermont and Canada, it maintains a remarkable uniformity in composition, structure and other characters: the greatest change is in color; being lighter, in some parts of the mass, in some portions than others. The color sometimes is due to the presence of decomposing sulphuret of iron.

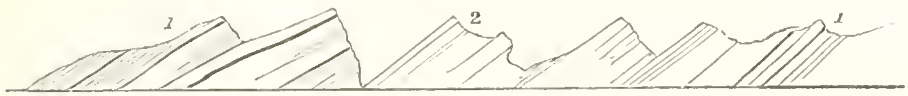
In speaking of the extent of this slaty rock, it has been questionable whether the range farther east, forming Saddle mountain, ought to be embraced under the same name. Without pretending to decide confidently in regard to the similarity of the two, I am disposed at present not to divide them. There is so much resemblance, that they may be considered as one rock, without leading to serious error. With this disposition of the question, we shall be obliged to give the rock a much greater extent; at the same time, it will be necessary that we remember that they are separated by the rock termed the *Stockbridge limestone*. Both masses of slate appear in mountain ridges, while the limestones form the valleys, and only skirt them at their bases.

3. Stockbridge Limestone.

I have applied this name to all those varieties of limestone which are associated with those masses that are usually known in market as the *Stockbridge marbles*. The only difference, of course, which can exist, are found in the colors and texture, of each of which there are numerous varieties, as snow white, and clouded with blue, either deeply, or merely a slight mottling; all of which vary in texture from very coarse to very fine. The differences in composition, taking in view the whole mass, are found to consist in the combination of magnesia, forming dolomites, and a mixture (not a chemical combination) of silex. The coloring matter appears to be derived from the slate which envelops it, and it probably consists of fine particles of slaty matter intimately mingled with the limestone. It is owing to this cause that the colors are so permanent and fixed; they never fade or appear to spread, or affect the stone by becoming more diffused through it. The tarnishes and stains which sometimes appear, are produced by pyrites, which decomposes slowly; the oxide of iron spreading in the stone, and imparting to it a dirty brownish hue. There are two kinds which are handsome when first removed from the bed, but are truly of little value: the magnesian limestone, or dolomite, which is tender and friable, and hence easily broken; and those in which pyrites is disseminated; these latter, though perfectly fair when first raised from the quarry, will lose their beauty by the decomposition of this substance. Those varieties in which silex is mixed, are usually fine grained and subject to disintegration, whether exposed to the air or beneath the surface. We often find a large bed of limestone beneath the soil, in which disintegration has proceeded so far as to form a cobble of loose stones; the process of disintegration having penetrated first into the fissures and natural joints, until the bed is perfectly broken up. In these cases, the pieces appear in some imitative shape, as the leg of an animal, or some other natural object, and the surface is covered to some depth with fine particles which may easily be fretted off.

This limestone is distinctly enclosed in the magnesian slate, and it is not possible to discover any difference of the slate on either side of the limestone: it is, in fact, one rock in all respects. The limestone commences with a few alternations of slaty layers, when the former soon appears well developed, and it disappears in the same manner. The thickness of the beds or layers varies greatly, being from one or two inches to two feet. It is often interlaminated with talcose matter; but this is sometimes so much diminished, that the layers appear merely sprinkled with flakes of talc. The following section exhibits the New-Ashford marble quarry in Berkshire county, Massachusetts:

50.



1. Alternation of slate and limestone. 2. Layer of pure limestone.

There is no question, in this case, of the true relations of this limestone, and of its being enclosed in the slate; and no doubt of its stratification, or of its being a sedimentary rock. Its eastern inclination is about 30°; and the quarry appears like a simple uplift, free from contortions or other disturbances which derange the strata.

The thickness of the whole quarry of limestone, of which I have given a section, is about three hundred feet. Of this mass, but a small portion can be worked as marble; and it is often the case that a single stratum, not over two feet wide, has to be pursued alone, in order to obtain the blocks of a suitable size. Under these circumstances, immense quantities of mere stone have to be raised and removed to secure the object aimed at. It is, however, sometimes the case, that the adjacent layers form an inferior marble of some value; a very large proportion, too, forms a good building stone, and an excellent material for lime, which to a certain extent are found useful.

There are several narrow belts of limestone which traverse the Hoosic valley from north to south; and it is a question of much interest to decide, whether those several belts are so many distinct masses, or whether they are the same, which are brought repeatedly up by an uplift. From inspection they appear to be different masses, so far as the character of the strata are concerned. We may safely consider, that there are at least two distinct belts of this limestone, one of which lies close upon the Hoosic mountain, and is in some parts quite coarse, in others rather fine, but in beds whose structure is much like gneiss. The latter is a very inferior limestone; in fact, when it desintegrates, it often leaves a distinct skeleton of silex of the original form; the limestone is apparently dissolved out, and the silex remains in a light porous mass. The other belt passes through the central part of Berkshire county, approaching occasionally the New-York State line. In some localities it is associated with granular quartz, and lies on both sides of it, dipping beneath it on the west side, and reposing upon it on the east.

This arrangement produces a complication in the geological structures of this system, that is quite perplexing. If the granular quartz is left out of view, however, and we consider it as occurring in accidental beds, a great part of the difficulty is removed. I shall have occasion hereafter to speak of these masses or beds of quartz, which are so anomalous in this formation.

In consequence, as it would appear, of the ready disintegration of the limestone, it always forms the floor of the valley, and the slates the mountain masses. Where the latter present to the weather their edges, they not only resist the action of the air, and of moisture, frost, etc., but also form a strong barrier to limit the action of floods and currents; but limestone, especially when mixed with silex or magnesia, is readily acted upon by atmospheric agents. There appears no method by which to account for the position of the limestone, other than the one here offered; for originally, there can be but little doubt, the latter rock was coëxtensive with the slate. The valleys furnish themselves evidence of having been formed by denudation, at least in part: and as the slates, from their peculiar structure and position, are capable of resisting chemical and mechanical forces to a much greater degree than limestone, they remain in mountain masses, while the limestones have been perfectly furrowed and worn down to their present level. Other rocks, as granular quartz, when lying in the midst of limestone, have also remained, forming high hills, while the limestone at the base on both sides appears in the lowest depressions of the valley. This is the case around the base of the hill in Williamstown, Mass., known locally as Stone hill. In the valley of Berkshire, instances of this nature are common.

Valleys of Berkshire, and water drainage.

In the preceding remarks, I have omitted the limestone which lies in Williamstown, at and upon the east base of the Taconic range, for the reason that some doubts exist whether it is really distinct from that which underlies the middle part of Hoosic valley, or not. It is separated from it by the mass of granular quartz which forms Stone hill, and dips beneath it. It is a mass three hundred feet thick; and in the same range, one mile north, a similar bed appears, which is probably the same prolonged in this direction; so, to the south, this same bed appears to continue, taking the course of the valley of the west branch of Green river which comes from Hancock. If this mass of granular quartz was continuous, there would not be so much uncertainty in regard to the different beds of limestone. When, however, we find the limestone of the middle part of the Hoosic valley commingling, as it were, with this lateral and western bed of limestone on reaching the south end of Stone hill, all the limestone of the valley appears to belong to one great bed, and the granular quartz to be embraced in it, in the form of a great bed also.

Again, following the mass in the direction of the west branch of Green river, we find a limestone dipping beneath, or plunging into the South mountain, a mountain lying mostly between New-Ashford and Hancock: this, it would seem, must be the same mass which dips beneath Stone hill. Some doubts then may well be excited whether, as has been suggested,

these two beds of limestone (the one filling the central part of the Hoosic valley, and the lateral or western one) really commingle at the southern extremity of Stone hill.

Some of the difficulties relating to the continuity and identity of the several belts of limestone arise probably from the uplifts which form the short spurs of mountains, which, rising up in rather interrupted lines, create confusion by crowding the beds of limestone, or other masses, out of the true line of their strike. By admitting this westerly mass of limestone, or that on the eastern base of the Taconic range, as one distinct from the Adams range and that of the Hoosic valley, we shall have three parallel beds of the Stockbridge limestone. By reference to section 46, it will be observed that I have represented a bed or mass of limestone at the west base of Saddle mountain, marked 2, or *Second bed of limestone*. This is full five hundred feet thick, lies in the magnesian slate, and does not rest upon it, or rather against it, as has been supposed by some geologists. I suppose this rock to form the great repository of the Ashford, Lanesborough and Stockbridge marble. It appears on the south slope of this mountain; or that slope which forms the north side of what is called the *Hopper*, immediately beneath Graylock. It strikes across the deep ravine which runs up to the Hopper, and appears forming a part of the next mountain south, which is a west spur from Graylock; and in the same direction or strike, we find the New-Ashford quarries of marble. In the section just referred to, I have represented upon the right of the fracture, at figure 2, curved strata. These curved strata form, I suppose, the valley of the Hoosic, or mainly that part of it on which the pleasant village of Williamstown, with its College edifices, is situated. It will be observed by the most careless that the strata of limestone are remarkably bent and contorted, forming in many instances double curves.

In relation to the two masses, one forming the valley of the Hoosic, and contorted in this remarkable manner, and the mass represented as the second bed of limestone, and plunging into Saddle mountain, I now consider them as the same, the latter having been broken from the former by an uplift. We have, however, to go so much by conjecture in these questions, that it is rare that we can enjoy the satisfaction of being certain we have the truth.

Again, referring once more to the contorted limestone, I am often disposed to attribute these flexures to other causes than lateral pressure. They appear often too much bent and folded upon each other, so as to look like concretionary masses; and in some cases, these irregularities might be produced in the same manner as the contorted layers in clay beds; by deposition upon irregular surfaces, washing out the lower layers, by which those above are left unsupported; or by irregularities in currents, etc., by which unequal and irregular deposits take place.

I will now leave this subject, perhaps without having thrown much light upon it; in hopes, however, that it may yet be elucidated by abler minds.

Veins and other foreign minerals in this limestone.

It is incorrect to call this a metalliferous rock, yet a few instances have occurred of its containing lead and copper. The former is the sulphuret of lead, or galena; and the latter is also a sulphuret, forming the pyritous copper. No veins of either have yet been discovered, but they both occur in small masses, and of little importance.

A vein of quartz exists in Williamstown, traversing this rock with great regularity. It is two feet wide, and its course is N. 54° W., with a steep dip. It is nearly a mass of pure milky quartz, abounding in beautiful crystals which have some curious irregularities in the extent of their faces. In a great proportion of them, there is a tendency to extend, so that the remainder are nearly obliterated.

The most interesting mineral in this limestone is albite, which occurs in Williamstown, (Mass.), Granville (N. Y.), Castleton (Vt.), and probably at numerous other localities. It is often transparent, and always in twin crystals. I have found them an inch in length, but commonly only from one-fourth to one-half an inch. Calcareous spar, and brown or pearl spar, are associated both with the quartz and feldspar. Sulphuret of iron, in simple unmodified cubes, is of frequent occurrence, generally in the talcose and slaty varieties. Scales of talc appear sprinkled upon the lamina through almost the whole mass. Brown tremolite is also found in small bladed crystals, and in small confused groups.

Note. I omitted to notice, in its proper place, the fact that native copper is occasionally found in the Taconic slate. It was not my intention to speak particularly of the mineral contents of these rocks. This led me also to pass over the galena in the sparry limestone, without a notice of it.

4. Granular Quartz.

This rock has a composition quite homogeneous; and though I have sometimes spoken of it as a sandstone, still it hardly admits of this designation. Its particles are small siliceous grains, slightly crystalline; but they do not appear to have been formed from abrasion of a preëxisting rock, like the ordinary sandstones. We cannot discover particles of mica, or any angular or rounded fragments of older rocks. It is true that fine abraded particles, almost impalpable, will, under pressure and other favorable circumstances, become homogeneous and crystalline.

There are two views which may be taken of this rock: 1st, that it is composed of the fine debris of preëxisting rocks abraded mechanically, and which have united and formed one homogeneous mass; or 2d, that this rock is the product of thermal springs, which of course must have been large, and existed in the earlier era of the earth's history.

Which of these views is the most rational, and most worthy of adoption, is difficult to decide. In favor of the latter, it may be stated, 1st, that we find no particles of mica, or any rounded particles which appear to have been rolled and ground by attrition, or to have existed in other rocks, as granite or gneiss; 2d, this rock lies along a disturbed district in which

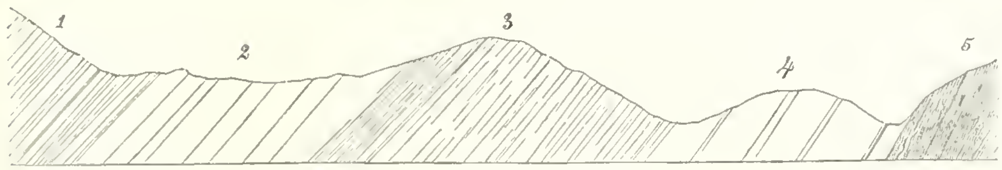
thermal waters still exist, though it does not appear that they deposit any thing but tufa at present; 3d, as has been stated above, it is homogeneous and similar throughout, though rather coarser than the siliceous rocks which we know have been deposited from thermal waters; 4th, it occurs apparently in insulated beds, which bear the semblance of having been made by some local cause. The granular quartz is traversed by veins of white amorphous quartz, which appear to have some degree of regularity in the direction which they pursue.

The color of the rock is usually brown; upon the outside lighter, or grey, upon a recent fracture. Beds or masses are sometimes snow-white and friable, passing by disintegration into a sand with a sharp grit.

The varieties which I have observed, are, 1st, the common hard rock, crystallized into rhombic prisms; 2d, the distinct white granular kind, which ultimately becomes sand; 3d, a compound rock in which feldspar exists in small crystals of white or yellowish-white color. The latter is subject to decomposition; the feldspar disappears, and leaves a porous quartz, which has been employed for millstones, and which slightly resembles buhrstone. This variety has been largely formed in some localities, as in Pownal (Vt.), where a large bed of porcelain clay has been found, which probably owes its origin to the decomposed rock.

The relation which this rock holds to the others belonging to this system is exhibited in the following section, which extends from Adams to the base of the Taconic ridge, over Oak hill, in Williamstown:

51.



1. Hoosic mountain, composed of gneiss.
2. Stockbridge limestone, valley at Adams.
3. Oak hill, of granular quartz.
4. Limestone.
5. Magnesian slate.

The dip and strike of the beds of this rock conform to the other rocks of the system; the the strike being N. 10° W., and the dip 30° E.

On Stone hill, the great mass of quartz is divided by a thick bed of dark blue siliceous slate. This slate is tolerably even-bedded, and answers a good purpose as a flagging stone. This hill is about one and a half miles in length, and arises out of the Hoosic valley in a perfectly insulated state. It is about four hundred feet high, and presents upon the west side a high mural front of hard granular quartz. In the line of direction, another mass of this rock appears, but it rises only just above the surface, and is quite inconspicuous.

A more important bed or mountain range lies north of the road leading from Williamstown to Adams. This mountain is fifteen hundred feet high, and apparently extends fifteen or twenty miles north, preserving its mountainous character, and rising apparently still higher in a ridge between Bennington and Woodford (Vt.).

Another important mass of granular quartz, in this last range, appears fifteen miles south in Dalton, in close proximity with the primary of the Hoosic mountain range. Monument mountain, in Stockbridge, is another great mass of this rock ; and still others exist. All the examples of this rock are insulated, or surrounded by other rocks, as if they were great beds in the latter.

The stratification of this rock is more or less obscured by the crystallization of its layers. It furnishes but few instances of contortion, while, as has been stated, they are extremely common in the limestone which lies in immediate contact with it. One beautiful instance of curvature and fracture has been noticed in this rock in Williamstown, on the west side of the hill opposite the burying ground. The section No. 52 is a representation of the fracture and curvatures here referred to :

52.

This curious and highly interesting case of contortion occurs in the western slope of the hill. The strata dip to the east as usual ;* and this mass of quartz, which is more slaty than usual, lies between two beds of limestone. In this instance, there is the uplift accompanied with the effects of lateral pressure, which formed not only a double arch, but here so powerful as to break the mass nearly in the centre between the two arches, and the portion on the north side is thrust up so as to override and overlap the other. At the line of fracture, the surface is partly crushed and partly rolled into short cylindrical pieces, giving at the same time to the adjacent laminæ many short and unequal curves.

This I take to be an instance in which the flexures of the strata have been really produced by lateral pressure : it certainly does not belong to a doubtful case, in consequence of the fracture the layers have sustained. In this instance, however, it would seem that the pressure was confined to a few feet thickness of rock ; for from what appears, about eight or ten feet was raised up from the strata beneath, and to these few layers the pressure might have been confined. There is at least a small cavern or space beneath, which seems to have been formed by raising up the strata forming the roof, from those which form the floor.

The granular quartz is the least regular in its occurrence, of any of the rocks of the Taconic system ; it generally appears in insulated mountains, surrounded apparently by other

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* The preceding cuts, Nos. 49, 50, 51 and 52, were not reversed by the engraver, and hence the dip and other characters are misrepresented.

rocks, furnishing us with a probability only of being prolonged in one direction. At an uncertain interval it may appear again, as it were forced up through the other rocks, and attended uniformly with precisely the same conditions. In Williamstown, it apparently forms part of two interrupted ranges: one near the eastern base of the Taconic range; the other, near or at the base of the Hoosic mountain range. Along the latter line, some of the heaviest masses of this rock appear; thus, Oak hill, between Adams and Williamstown, rises fifteen hundred feet, as already stated. In the east part of Bennington, in the same range north, is a much larger mountain; and at the south in Dalton, at the Gulf, is another mountain of the same material. The western range, if one exists, is far less important: it is less in extent, and less regular in its appearance.

Granular quartz is rarely if ever traversed by veins, except those of a siliceous kind. Disseminated in fine particles, we frequently meet with sulphuret of iron; in fact, a very large proportion of the rock is brown on the outside, from a stain derived from the decomposition of this substance near the surface. As a mining rock, it is of no importance; but it is a valuable rock in itself, especially those parts of it which are granular, and those which are the least crystallized in the mass. This kind forms an excellent firestone, and is employed for furnace hearths. It is also a good building material, whenever it is sufficiently separated, or broken up in the mass in the direction of the layers and natural joints. The white granular or arenaceous variety is an excellent form of silex for crown glass, for sawing marble, sand paper, scouring, etc. The ordinary hard variety of quartz decomposes slowly. The region, however, in the neighborhood of this rock, is greatly infested with loose round fragments of the size of paving stones. In some places the soil is filled with them, and they are exceedingly troublesome in roads. In consequence, too, of its hardness, most of the boulders in the range of the Taconic system are of this rock.

Mineral Products derived from the Slates and Limestones of the Taconic System.

The most abundant product derived by decomposition from the slates and slaty limestones of this system of rocks, is *hematitic iron*, or limonite. The original state of this ore must have been partly that of an oxide disseminated in that part of the system where the limestone and slate come together. We often find talcose layers, yellow, ochrey, and white argillaceous matter commingled together in various states of change; some having become a perfectly soft or earthy stratum, and others harder and less changed, but still retaining some of the characters of the rock. From such a source, it is conceived the hematitic ore originated. After decomposition and disintegration, the earthy matter, charged with the oxide, accumulated in some partially closed valley, where it underwent a further change by a more perfect separation of the oxide. In process of time, the arrangement of the materials becomes as we now find them; the pure oxide in masses enveloped in an ochrey clay, with bands of white clay, which is one of the purest forms of this substance. A still farther change has sometimes taken place, by the conversion of the clay into gibbsite, which change is precisely analogous to what takes place in the conversion of the ochre into limonite. Intermixed with hematite

is the earthy black oxide of manganese, which also passes through the same changes as the preceding minerals. Even carbonate of iron is sometimes present, passing through this order of changes: first, it is enclosed in fine particles in the impure limestone, which, decomposing, finds some hollow or basin that retains the matter, and prevents its transportation to the sea and other great reservoirs. When quietly deposited, a series of changes take place, which end with the perfect reünion of the particles in solid crystalline masses. In all these changes, no heat is required; a combination with water to give mobility to the particles, is all that is necessary. When the materials are partially soluble, we find a most perfect crystallization; but even where the insolubility is great, as in the oxide of iron, we find that a state of mobility results in a regular arrangement of the particles.

That the preceding views are correct in relation to the origin of hematite, manganese, etc., appear quite probable, from the fact that these ores occur only in the Taconic system. We, in fact, never find them out of the belt of country traversed by these rocks. Thus it appears proper to place those products in this system of rocks; they were originally a part of it, and subsequently, by decomposition and transportation, were removed to some other place within the bounds of these rocks. It will be observed, that though the products of this rock are few in number, they are still highly important, and worthy of careful investigation. At short intervals only, these products are carefully treasured up, for our use. We know the general range of the system, and knowing that it is within its bounds that these varieties of iron and manganese are to be found, we are furnished with a clue to their discovery. Probably these beds will be found extremely numerous; it ought to be borne in mind, however, that they are by no means inexhaustible, and that they are accidental deposits, and that they may be entirely removed in process of time.

Some of the hematitic beds furnish an excellent ore, or one suitable for the most perfect productions in this metal. It is an interesting fact, that New-York contains within her bounds four species of iron ore: 1st, the magnetic of the Primary; 2d, the specular of the Primary also; 3d, the hematites of the Taconic system; and 4th, the argillaceous or oolitic of the Ontario group. Each of these ores occupy different geographical as well as geological positions or relations. The two first belong to the original constitution of the earth, and the two last are formed from the decomposition of materials preëxisting in another form or condition. To these species, we may add the bog ores of still more recent formations; they are products of our own time. It is to be observed, too, that their distribution is extremely favorable to supply the wants of the inhabitants of New-York. The east, the south, the west, and north, have each their ores of iron. The highlands, which are broken and mountainous, furnish all the magnetic ores; the hilly and moderately elevated, the hematites; the rolling and swelling country of the west, the oolitic, or argillaceous.

Conclusion.

Before dismissing the subject of the Taconic rocks, it will be useful to state very briefly a few facts of a general bearing:

1. This system is important in an economical point of view, in being the repository of the white and clouded marbles: it is probably the only system in this country which contains any marble suitable for statuary.

2. It has already been stated, that it is this system which furnishes all the hematites and black oxide of manganese.

3. It is the most productive system for furnishing the white siliceous sand for glass, sawing marble, etc., or a sharp-gritted material for sand paper.

4. The belt of country traversed by the Taconic rocks is one universally productive: The hills are generally susceptible of cultivation to their tops; the valleys, which are underlaid by limestone, are rich; and though there is not a great depth of vegetable mould, the soil is strong, and not soon exhausted: the land is suitable both for tillage and pasturage.

5. An interesting fact will be observed in relation to the kind of boulders distributed over this belt of country, viz. the extreme rarity of those belonging to the primary rocks. A few appear along the eastern edge, adjacent to the gneiss and granite; but towards the centre of the formation, it is extremely uncommon to meet with one. This fact is not confined to a small territory, but I believe prevails through the county of Berkshire, and to a great distance north. The boulders in part belong to the rocks of the Taconic system, and are mostly granular quartz, which resists for a great length of time the agency of the weather. Boulders of limestone are extremely rare.

6. The valleys of this system of rock are in character with the system itself: they are long and narrow. They have been formed probably by the combined operation of two distinct causes: 1st, by uplifts which have first fractured the strata; and then, 2d, by excavation, not wholly by the present water courses, but by some more powerful means. The streams which now flow in these valleys, are generally rapid, rarely sluggish, and more rarely furnish imposing water falls. They are all subject to rise rapidly, and endanger bridges. Vast amount of damage has accrued to the country lying in the range of this system of rocks.

7. Since the general uplift of the country, very few disturbances have appeared to occur; and it is very remarkable that trap dykes and injected rocks of any description so rarely occur. I have, for many years, passed over them in various directions, and I have never yet seen an instance of the kind.

8. The Taconic rocks appear to be equivalent to the Lower Cambrian of Prof. Sedgwick, and are alone entitled to the consideration of belonging to this system, the upper portion being the lower part of the Silurian system.

In conclusion, I would remark, that in drawing up my account of these rocks, I have felt that much less interest will ever be attached to them, in consequence of their entire destitution of fossils. They are to be considered, however, as furnishing us with a knowledge of that state which immediately preceded the existence of organic beings; they furnish one link in the history of the earth, which is necessary for us to possess before we can by any means consider our knowledge as being at all complete, or as full as is necessary if we would reason correctly.

CHAPTER X.

GEOGRAPHICAL GEOLOGY;

Or an Account of the Rocks of each County in the Second Geological District.

GENERAL REMARKS.

The object which I propose to accomplish in giving the geology of the counties separately, is to enable me to present a more detailed account of those natural productions, which will possess principally a local interest. I am the more disposed to follow this course, as I have reasons for believing that it is expected; and that there is a local interest felt, aside from the general one, which has always manifested itself whenever the subject of the survey has been spoken of: besides, it will be in accordance with the arrangement of the collections, and will furnish a convenient method for comparing different parts of the State with each other. It brings home, too, the useful materials, and places them at every man's door; for almost every individual who transacts business, is generally well acquainted in the territory and with the localities within the bounds of the county lines in which he resides. Useful knowledge, however, is not restricted to the *positive:* it also takes in the *negative;* so that, in order to be complete and satisfactory, it ought to embrace the latter. But much of that which is negative, does not require positive expressions, but is furnished by the establishment of principles. But in the present state of geology among the people at large, it will be giving probably too much credit, to suppose that those principles are sufficiently well understood to enable them to make their application, even in ordinary cases, much less in those where obscurities exist.

In the details which will appear in the subsequent pages, it may often seem that there is a great want of some of the most valuable and useful productions; of those, too, which many were very sanguine would be found in the course of the survey, such as coal, iron, silver and other precious metals. These hopes not being realized, those persons may still suppose that a plan more thorough, and means more efficient, together with keener eyes, would have secured the realization of their expectations. On inquiring into the grounds of belief in many instances, it is both curious and amusing to learn on what such expectations rested. Looking

upon their barren district, they infer, that inasmuch as Nature has stin'ed, or has been sparing in the bounties which accompany a fertile soil, they must of necessity abound in something else that is valuable; as if she was bound, or rather as if that was a part of her system, either to make a district fertile, or else to abound in products of merchandise. It is scarcely necessary to attempt to dispel such an illusion; for illusion it must be, inasmuch as these notions cannot have been derived from observation, or from a knowledge of the economy of nature in any of her dominions. It is true, however, that in one sense every region and district is fertile, or contributes to fertility; almost every one yields the necessaries of life to the industrious and temperate, they are rich in beautiful scenery, the heavens above are not brass, nor the earth beneath an iron-bound sod. The scenery which is spread out upon all sides is magnificent to behold; the mountains, which rise in sharp ridges and peaks, yield, it is true, no harvest of corn, but they may be considered an essential feature in the physical arrangement of the earth; the majestic mountains, and the broad expanse of ocean, are necessary accompaniments of the fertile plains: the husbandman, it is true, does not go upon either for tillage, yet without them all would be a barren waste. What may be wanting in one district, can be supplied by an exchange of commodities; industry will create mines, make a barren spot fertile, and bring to every man's home and family the products of every clime and season.

In the previous part of this volume, I proposed a classification of the rocks of my district; and at the same time applied the principles on which my views were founded, to the several districts of the State. Farther reflection upon the subject, and the favorable opinions of friends, have confirmed the views which I then gave. By reference to p. 101, it will be seen that this classification is geographical, but still the divisions are not strictly arbitrary; for it is conceived that the groups, though they may be susceptible of farther division, are by no means unnatural, and neither of them includes rocks which can with any propriety be placed in either of the others. Those groups then may contain too much, according to the views of some geologists; that is, embrace a small series which might be subdivided or thrown into two or more smaller groups. Of the propriety or advantage of splitting up the system into numerous subdivisions, there still exist many doubts. While this question may remain undecided, there can be but one opinion in regard to the advantage of retaining the geographical features of the classification; for our conceptions of the New-York rocks are greatly aided by associating the two great aspects under which rocks may be viewed, viz. as existing in *time*, or in *space*;* or in other words, superposition and geographical range; so that where one is the subject of reflection, it necessarily brings to our minds the other. By no better method can these advantages be secured, than by the one proposed, viz. the division of the New-York rocks into four great groups — the Champlain, Ontario, Helderbergh, and Erie. Each group having, it is believed, a tolerable distinct boundary on either side, both above and below, so geographically they are equally well defined by lines easily followed, and which

* Hugh Miller on the Old Red Sandstone, p. 256.

rarely intersect each other, or are liable to produce confusion by crossing over the bounds of the adjacent groups. This plan, it is true, is the same which is followed in regard to individual rocks, viz. giving them local names, according to the place where they may be studied to the best advantage; but it is rare that this principle of naming rocks can be followed up to so great advantage, as in New-York: the succession is rarely so clear, and certainly the combined circumstances can never exist in so favorable conditions to carry out the plan in full, as in this State.

It has been already stated that the rocks of the Second district belong to the lower part of the Silurian or New-York system. If we are to rely, however upon the information of foreign geologists, and receive without hesitation or examination the classification and divisions proposed, we might be in danger of being led astray by authority. In the instance of the lower rocks here referred to, we should probably place them in the Cambrian system, provided there is sufficient evidence that such a system exists independent of the Silurian. Soon after the commencement of the New-York survey, it became necessary to compare the rocks of the Second district with those of England; and it soon became evident that some of them belonged to the Cambrian system. The slates of the Champlain group, for instance, possessed all the characters of the upper members of this system. On comparing these slates, however, with those in the northwestern part of the Second district, it was very clear that the only difference between them is, that on the east they are disturbed and greatly inclined, while in the west they are undisturbed or only slightly inclined to the south. Of the latter rocks, there could be but little doubt they were truly a part of the Silurian system of Murchison; at least if reliance could be placed upon books, for I had no specimens by which to compare the rocks of the two series. The Caradoc division, it was tolerably certain, terminated with the Medina sandstone. Now in New-York, the rock immediately beneath this red rock, or red marl, in some places is a grey even-grained sandstone, to which succeeds the shales and slates which have in some parts at least a strong resemblance to the Llandeilo flags. We, however, have not as yet been able to identify them throughout by their fossils: the *Asaphus tyrannus* and *buchii* have never been found in this country. But however this may be, whether the rocks beneath the Medina sandstone are equivalent to the Llandeilo flags or not, they are evidently a part of the system of rocks which precede them. There is too much resemblance and affinity between those below and those above, to make of them two distinct systems of rocks. There is, it is evident, quite a distinct line of difference between the Medina sandstone and those below, yet the change is not that which marks a very distinct era in passing from one to the other. If then the western shales and slates were silurian, it would follow that the eastern division of them is also silurian. It became a question, then, whether this portion of the cambrian had not been mistaken or misunderstood, in consequence of the disturbances and changes to which they had been subjected. This was the early conviction which was forced upon my mind, and I was led to state this result in the American Magazine, a monthly periodical at that time published in this city. Those rocks which have been termed *cambrian*, have certainly given their full share of trouble to the geologists of both countries. In this,

they had long been considered as the lowest of the transition rocks, and as resting upon the primary; and this is unquestionably true in some instances; but it was not suspected that there was a thick mass of sedimentary rocks beneath, abounding in fossils, and filled with organic relics. The clearing up of these two points, the mistake in regard to the lower part of the silurian rocks, and the establishment of the fact that they rested not on primary rocks, but upon other fossiliferous strata, were real advances in the science.

Another point which it is proper to speak of in this place, is that which relates to the smaller divisions of the rocks. In the Second district, there are several masses which I have described as rocks, but still would consider as subordinate ones. In a general treatise, it would probably be sufficient so to consider them; but in this report, it appeared essential that all those masses which have been or may be employed for important purposes should be distinctly noticed and receive a name, inasmuch as they have a place and character by which they may be recognized. Thus, the *Birdseye limestone*, though its name be objectionable, yet I have preferred to treat it as a rock, though it may be subordinate to a larger mass of limestone. The same may be said of the *Black marble* of Isle La Motte: it is a thin mass, and may be spoken of as a part of the *Trenton*; yet it is a very important rock, or mass, as it furnishes all the black marble of the northern section of the State. The *Chazy limestone* is a much thicker rock than either of the preceding, and appears to be so distinct that it can hardly be doubted that it is worthy of a place in the catalogue of New-York rocks. My colleague, Mr. Vanuxem, however, has grouped the three rocks cited above under one name, the *Black-river limestone*. It appeared then that this fact should be stated, and the matter explained, in order to clear up questions which might arise in relation to the three masses, which, for the reasons above stated, I have presumed to separate, instead of describing them under one appellation. It should be borne in mind, that they may be easily recognized even by the lithological characters in most instances, though this character is rarely important when applied to any but primary rocks. I have, however, been uniformly disposed to restrict the number of New-York rocks; that is, not to multiply divisions unnecessarily, and without cause. We may often find a thick mass in the midst of a formation whose characters are somewhat different from those above and below, and yet it will be entirely inexpedient to notice this mass as a distinct rock; and again, as in the case of the black marble in the Champlain group, though thin and apparently unimportant, yet it will be found highly useful to notice it as a distinct rock, in consequence of its value in the arts of life. While some differences of opinion may exist as it regards individual rocks, there will probably be none where the first great division is to be made; for we do not find it at all convenient to make this, till we reach the Medina sandstone. All the rocks below, belong as it were to the era characterized by certain forms of life — the Strophomena, Orthis and Atrypa, etc. The grades of existence, as found in these oldest of sedimentary rocks of the globe, do not, however, support and sustain the views of many geologists even of the present day. The gradual progression from the low to higher ranks in the scale, do not seem to be borne out by the fossils of these lower rocks; at least not in the positive agreement of fact with theory, as has been the custom of some to teach. It is true, that as yet no remains of vertebrate

animals have been found—the scales of fish, or any of their parts; but that the condition of the water was not suitable for beings of this grade, is by no means proved; and if suitable, why may not the existence of these beings therein be admitted? One discovery after another is made, by which the higher and more perfect forms come to us from greater depths; and are there any geologists who, in advance of observation, can predict that from beyond such a depth no vertebrated being can come?

In pursuing the geology of the several counties of the Second district, it is still to be borne in mind that the sedimentary rocks belong to two great and independent basins: those which lie upon the southwestern slope, embracing the county of Jefferson and a part of St. Lawrence, belong to the great Atlantic basin; and those which rest upon the northeastern slope, embracing the sedimentary rocks of Lake Champlain, belong to the St. Lawrence basin. Between these two slopes is the anticlinal ridge; but as this ridge runs in zigzag directions, and is extremely difficult to trace in a wilderness over one hundred miles in length, and as there is besides a great slope from a central region, I have preferred to represent the axis or anticlinal ridge in the light of a culminating point, formed by the Adirondack group of mountains clustering around the sources of the Hudson, Ausable, Racket, and Black rivers. These slopes form the extreme edge or circular rim of these two great basins respectively, the central parts of which are found, one to the north in the coal-field of New-Brunswick, the other to the south in the coal-fields of Pennsylvania. Regarding the subject in this light, we find that the series of rocks forming the lowest deposits of these coal-fields are the same; that the series goes on and progresses with equal steps, each step having nearly its fellow in each formation; each sea filling up nearly equably with materials derived from the neighboring continents; and each arriving, after an equal number of sedimentary masses, to that great era, the *Carboniferous*. Then could be seen, extending through forty degrees of latitude, the arborescent fern, hanging in rich festoons along the shore; the graceful pine, with its regular set branches and pointed top; the jointed palm, with long pendent leaves: these, with many similar forms, made a vegetation peculiar to an era whose only record lies buried in the debris of a lost continent, whose granitic hills were worn and furrowed by agents not distinct from those of this present day. We see the same materials, once a solid rock, now spread out in sheets or leaves, which, when raised, bear each a record of the history of its own time; each has its fact, and as if that fact was so extraordinary, the record is repeated in distant parts of the globe, that it may command our belief. The era of the coal is but one among many, some of which are strongly marked in the annals of the history of the earth; but this is more distinct than others, and forms an important stage in the acquisition of a knowledge of the extreme past, where we may stop and review the several steps of our progress, and the ground over which we have travelled. It is a *middle station*, from which we may look back upon the series to the earliest glimmerings of light, or forward to the present, when the full light beams upon us.

Commencing then with the idea that the sedimentary rocks, those which contain organic relics, belong to two great basins, and remembering the order in which they occur, the great and leading facts of the geology of the northern district become easy and simple. These rocks, however, are of but small extent comparatively; still they are regular, and lead us

directly as far as they go, and with all the certainty and satisfaction of wider and more extended formations.

I shall begin at the southeast corner of my district, at the head of Lake Champlain, and thence cross over to the St. Lawrence in the order of the counties.

WARREN COUNTY.

Warren county, with the exception of Essex, is the most hilly and broken in the Second district. The hills and mountains are frequently steep, presenting a large surface of naked rock, or one that is only partially covered with soil and low shrubs. Those who have studied scenographic geology, would recognize at once the character of the predominant rocks, and be led to refer them to the earliest era of the globe. The most elevated tracts rise to a height of three thousand feet; by far the greatest proportion, however, of hills and mountains, are much less, varying from six to fifteen hundred feet.

Warren county, together with the greater part of the Second district, has always without doubt maintained a position above the level of the ocean; for we find no remains of rocks belonging to the sedimentary class, except in the lowest part of the district. The steep sides of the hills and mountains have been exposed to the washing of torrents for long periods; the soil has had no opportunity to accumulate, but as soon as formed by the disintegration, has been hurried down the steep declivities to the plains below. There are no soft and easily decomposable rocks which form a soil rapidly, as the slates and softer sandstones, but all are hard and impenetrable to moisture, except in the cleavages and natural joints. By the freezing of water percolating into those seams, a division of the masses on a large scale is produced in the first place; these are subsequently reduced to pebbles by various atmospheric agents, and in this way a slow accumulation of soil is effected. In no district of this character, therefore, do we ever find full rounded hills, with gently sloping sides, possessing a susceptibility of cultivation to their tops; their outline or profile always remains sharp, and their sides steep, and generally furnishing only a thin soil for the nourishment and support of vegetation.

The four ranges of mountains which traverse the county.

The county is traversed by parts of four ranges of mountains: On the east, the Black or Tongue mountains occupy the eastern or southeastern corner; in the middle, a belt about six miles wide is occupied by the Luzerne range; still farther northwest is a more elevated range, of which Crane's mountain is the highest in the county, rising to an elevation of three thousand feet above the plains of Warrensburgh. This mountain presents in profile the parts of the human face, from any point upon the eastern side, but particularly so when seen from

the plains of Warrensburgh. In the northeastern corner, a fourth range completely breaks up the surface, and throws it into numerous peaks and sharp ridges; it rises north of Johnstown, and runs northeast, and terminates at Willsborough falls on Lake Champlain. These four ranges are more or less connected intimately by lateral spurs, which, on a superficial view, become one connected mass of mountain ridges and peaks. The French mountain is an unimportant ridge five or six miles long, lying along the southern extremity of Lake George. A feature common to the whole mountainous region of Warren and the Second district, is, that though as a whole, a range is formed, yet there are no long ridges which are continuous, but they are all broken up into short abrupt hills, with heights varying from five to fifteen hundred feet; in addition to which, we have the first class of mountains rising to four and five thousand feet.

Notwithstanding the great amount of broken and mountainous land in Warren county, there is still remaining much productive soil. Except in the highest parts of the mountains, one side or slope forms excellent pasturage for sheep and young cattle, and the plains and intervals a warm rich soil for any of the productions which are cultivated in the State, as corn, oats, wheat, rye, etc.

Lakes, water courses, valleys, drainage, etc.

There are three beautiful sheets of water, situated partly within the limits of this county: Lake George, thirty-six miles long; Schroon, nine; and Brant, six. The first is interesting in its location; it is at the extreme of the valley of Champlain, which opens into the wide and extensive valley of the St. Lawrence; it is one of the most southern points to which this last named valley reaches, and forms a part of the drainage which flows north to the gulf of the St. Lawrence, being within about two hundred miles of the mouth of the Hudson river: but it extends about fifty miles south of the sources of the Hudson. The first range of mountains west of Lake Champlain forms the barrier for this distance, which separates the waters of this lake and Lake George from those of the Hudson river.

The principal drainage of the county is to the south, through the two branches of the North river; the Schroon branch, and the Hudson river proper. The former flows through Schroon lake, has a south direction through the whole county, to near the corner of Caldwell and Warrensburgh, where it turns west, and in the course of a few miles unites itself with the main branch of the Hudson river, near the southwest corner of Warrensburgh. These two rivers receive the smaller streams, forming themselves the main channels by which the county is drained. The declination of this surface of the county is south. It is situated in part upon an inconsiderable anticlinal axis.

The valley of Lake George extends four or five miles south of Caldwell, in the direction of Corinth; and to pass the dividing ridge between the waters of the lake and the Hudson, requires but a slight elevation. By this valley, that of the St. Lawrence opens into the Hudson, which soon becomes a broad open sandy country in the county of Saratoga. These broad sandy plains appear to have received the loose materials from the north, through the same courses and valleys in which the Hudson and its tributaries flow.

Geological character of the mountain ranges.

I may now speak of the geological character of the mountain ranges. All but the rocks of the extreme northwestern angle of the county are gneiss in the main, or this appears as the predominant rock; subject, it is true, to interruption, for limited spaces. Granite, primitive limestone and serpentine appear as intertruded rocks. Upon the east, the Tongue mountain, running down between Lake George and the southern extremity of Lake Champlain, is clearly gneiss. The French and Luzerne mountains are gneiss, with some granite and hornblende. The range of which Crane's mountain forms a conspicuous part, is gneiss, with granite of a decomposing kind at its base; while the entire northwest angle is composed of hypersthene rock, forming as it were a flank to the great central chain which extends from Little-Falls to Trembleau point on Lake Champlain.

In all these ranges the general dip of the strata is westerly, and they strike obliquely across the main axis of the range, in a direction more easterly than that of the chain.

In the gneiss of these several ranges, there are no characters so peculiar as to require remark, it is all of the ordinary kind, with the same intermixture of hornblende that is common to this rock in other sections of the State.

The same remark may be made as it regards its imbedded minerals; there is, in fact, a want of them, especially those of an interesting or useful kind. Imperfect crystals of hornblende and garnet are not uncommon. It is rather an interesting fact, however, that mica slate does not make its appearance in any of these ranges. It might probably be too much to say that occasional layers may not be found which would pass for this rock; still, generally speaking, it forms no part of the rocks of Warren or of the other counties of the Second district. We have, therefore, the parallel fact that minerals peculiar to mica slate are not found at all, as staurotide, kyanite, and but very small quantities of garnet.

But primitive rocks are rarely entirely destitute of mineral substances, and so we find it here: iron appears to take the place of all others, either in the form of veins, strings, or smaller imbedded masses. Iron ore of the magnetic kind is not unfrequent, but it does not occur in considerable masses. The largest and most important vein is that known as the one owned by Mr. Roberts of Caldwell, which is on lot No. 80, Hyde township. At the surface it is four feet wide, and increases in thickness in its descent into the rock. Other veins exist in Athol, Luzerne township, No. 16, and in the Brant lake tract. Most if not all are veins of sufficient extent to be worked, and are favorably located as it regards wood and water, but unfavorable as it regards transportation to a market. The most important facts relating to the occurrence of veins of ore will be given when the subject is reached under Essex county. The veins of Warren county, though they possess a local importance, yet they do not furnish that variety for illustrating the laws of connection between the rock and themselves, as those of the adjoining county.

GRANITE.

The most important mass under this head, is in Athol, at the base and in the vicinity of Crane's mountain. It is white, tolerably coarse, and contains but a small proportion of mica. The feldspar decomposes rapidly, and forms that important material called *porcelain clay*. A very large proportion of the bed is in a crumbly decomposing state. The precise extent of this kind of granite has not been ascertained; it is, however, known to continue with little interruption for nearly twenty miles. The importance of this rock is derived wholly from its nature, and its ready conversion into clay. I shall therefore speak more of this product of the rock, than of the rock itself.

The characters which predominate in all granites which furnish this material for the finest kind of pottery, are coarseness, with large plates of mica if any exists in the rock, and a white flaky talc, which perhaps appears only as a coating to the feldspar. A great length of time is required for the production of the clay; for the changes which the materials pass through are slow and gradual, and are effected by slow molecular attraction, which in the first place dissolves the tie that holds the mass together, and is preparatory to those nicer changes by which the potash is liberated from the feldspar, and the silex and alumine intimately blended in a soft snow-white mixture. Feldspar, which furnishes the clay, is composed of silex 64, alumine 20, potash 14, lime 2, or sometimes only a trace of the last substance. It is to the large quantity of potash that we are to attribute those changes which result in the formation of porcelain clay. The beds are not composed, as we should expect, of one homogeneous mass, but consist of layers of different colors; white, yellow and red predominating. Sometimes the distribution into layers is imperfect, and the white and valuable portion occurs in masses. In addition to the colored clays, the beds contain particles of quartz, nodules of manganese, and, what are quite interesting, large nodular masses of silex, of a secondary formation.

It will be observed from these facts, that the changes are of an interesting as well as of a complicated character. It will be useful to occupy a moment in an exposition of these changes, and the sequence in which they occur. We must first state one or two facts in relation to the solubility of silex. This substance, as it exists in rock crystal, when pulverized to a dust as fine as possible, is extremely insoluble by all the ordinary agencies. By means of potash or either of the alkalies, aided by heat, it is rendered highly soluble; and while in this combination, weak muriatic acid, or even water, is also capable of holding it in solution. Silex is also contained in thermal waters; and when these are exposed to the air, and lose their temperature, the silex is deposited or precipitated in the form of a tough porous rock, around the places where the springs issue. In the formation of porcelain clay, which consists of alumine and silex, there is a loss simply of the potash; the production of which may be accounted for by a solution of the whole or part of the potash by the water. But to account for the regeneration of silex in a solid concretionary state, and even its crystallization as is found to be the case in the interior of these nodules, is not so easy a matter; for we cannot

avail ourselves of the ordinary means for dissolving the silex, as we have not the condition of a thermal water, nor caloric to aid the solvent powers of the alkali. The following suggestion is, however, offered in explanation of the phenomenon of the reproduction of silex in a solid state, and often under crystalline forms: The silex being derived from the feldspar, the moment the potash leaves the comp und, the integrity of the mineral is lost, and the silex and alumine then combine with sufficient water to give them mobility; the silex is, however, separated into its ultimate molecules, and as these cannot exist in a separate state, they recombine either in grains or regular forms; and these being still acted upon by molecular attraction, form the masses or nodules of which I have been speaking.*

Whatever *rationale* may be offered in explanation of this interesting decomposition, we are furnished with a beautiful instance of a natural and spontaneous decomposition or analysis of feldspar, as complete and perfect as can be obtained in the laboratory of the chemist; so perfect, indeed, that we are able to perceive each element side by side in its particular repository, with the exception of the potash, which has been removed in consequence of its ready solubility, and its little disposition to enter into combination with silex and alumine without the aid of heat. To assist our minds to comprehend more clearly the sequence of these movements, which result in the formation of concretionary masses, we may consider all the elements of feldspar as forming at one time a plastic movable mass like paste, and in which there is a perfect intermixture of the materials, or the elements which composed the feldspar originally. Under these circumstances, all the easily soluble matter as potash would be washed away, or removed by infiltration through the earthy materials. Those which remain, will be left to be acted upon by molecular attraction, which would be exerted between particles of the same kind. This influence brings into closer union the particles of silex in the immediate vicinity of each other; and which, by a continuance of the same influence, would produce a gradual accumulation of matter of increasing density and firmness, until finally those movements have been imparted to the greater part of the silex in the beds. The accumulations commence at numerous points, which are different centres of attraction, at each of which, there is formed a mass of silex, or hornstone, or chalcedony.

Analogous changes take place in the porcelain pulp, after the materials have been ground and formed into a pasty mass in the vats, in case it is suffered to stand long without agitation; for after long repose, it is found that concretions of silex have formed, indicating the commencement of a series of changes which would result in the production of solid siliceous concretions, and which, if suffered to go on, would finally affect the entire constitution of the mass, and completely spoil it for the purposes intended.

The oxides of iron and manganese, which are usually associated in these beds, are derived originally from the granite. In the beds they appear under two forms: first, as a coloring matter, forming the yellow, red or pink-colored clays; and secondly, as concretions which have been formed by the same process as those composed of silex.

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* The decomposition probably arises from the strong affinity of potash for water: the alkali is therefore the vinculum which holds the elements together.

In the granite of Athol, the manganese often appears incrusting the surfaces of the feldspar, mostly in the form of dendritic impressions. As the granite disintegrates and decomposes, the manganese also undergoes some change, by which it is converted into the coloring matter of the clay, and of course is very equally diffused through the mass. Subsequently, however, affinity again brings together the particles of those oxides in the form of globular concretions, which now exist in independent masses in the beds of clay. Carrying our views a little farther, we may suppose these same beds of clay to be subjected once more to the internal fires ; we should then see reproduced the original granitic rock. We have, in all these changes and transformations, beautiful illustrations of the alterations which may take place in the state and composition which the solid materials composing the rocks may undergo by a modification of the force of affinity. We have, too, abundant evidence that matter, though inert in itself, obeys the impulse of an invisible intangible power, which, though slow in its operation, yet always in the end produces many striking results.

The clay of Athol has been sufficiently tested, so far as its qualities are concerned, for us to determine its capability of being employed for china-ware, or the finer kinds of pottery. How large a quantity may exist, or how extensive the deposit may be, requires farther exploration, as those means of trial formed no part of the duty of the geological surveyors. In its appearance and mode of occurrence, it resembles the same substance as it occurs in France and England. It is uniformly composed of apparently different materials, or those whose colors vary exceedingly, some of which are snow-white, while others in contact are a deep red or pink. This being the case, it always requires careful separation, by paring off the colored portions from the white or pure masses. In addition to this, washing is resorted to, to effect a perfect separation of all that may color the paste. This labor, however, is performed by children and females, and hence is not particularly expensive. The manufacture of porcelain, and the finer kinds of earthern-ware, is, however, expensive, and requires a heavy investment of capital ; and hence the probability is, that the porcelain clay of Warren county will not be employed for many years, at least for the kind of ware for which it is specially adapted. Still there are some subordinate uses for which it might be employed. The white clay is soft to the touch, and free from that meagre harsh feel which is common to many varieties of clay. This is due partly to the exceeding fineness of the particles, and partly to the presence of a magnesian substance resembling talc, which is intermixed in the form of thin white scales.

Primitive Limestone.

This rock is of more frequent occurrence than granite ; its beds, however, are generally quite limited in extent, or rather frequently interrupted so as to appear as separate and independent masses. The characters of this rock have been fully given in the general account of the rocks of the Second district.

From an inspection of the location and position of the beds of limestone, it appears that the county is traversed by a broad belt of this rock, in the direction of the mountain chains, occupying at all times the lowest geopraphical position, or at least never forming the summit

or even any part of a mountain. It lies at the base, and forms low and inconspicuous hills in the valleys. This belt, imperfect as it probably is, passes through Athol, Johnsburgh, Warrensburgh and Chester, the district about Brant lake, and so on towards Lake Champlain. It is extremely varied in its characters: at one time it is a pure coarse granular limestone; at another, mixed with pyroxene, hornblende, quartz and scapolite; all which occur in the rock, in a mode precisely similar to that of granite, that is, invested on all sides by the rock, showing conclusively that the minerals are cotemporaneous with the rock itself.

This limestone is one of the most important rocks in the county, as from it all the lime for building and for agriculture may be obtained. It requires, however, careful selection when intended for these uses, rejecting those masses in which foreign minerals are disseminated. When the stone is properly selected, it makes the strongest of lime, a bushel of which is worth a bushel and a half of the ordinary quicklime made from the transition limestones. A very common error prevails in relation to this rock, most of the farmers mistaking it for plaster.

This limestone, as it occurs at the surface, is never suitable for building, being in a state of partial disintegration; but if obtained deep in the beds which have not been acted upon by atmospheric agents, it is firm, and appears durable. Still the grain is too coarse, and being a magnesian rock, it will sooner or later crumble and fall into decay.

This rock is rarely suitable to be employed as a marble, in consequence of its liability to disintegrate; besides this, it always contains hard minerals, as quartz, hornblende, augite, sulphuret of iron, etc., which interfere with its working. This limestone, therefore, ought not in general to be employed, except for making lime, especially when durability is an object. For this purpose, Warren county is well supplied, in addition to the limestones at Glen's-Falls, which are largely employed for quicklime.

It is important to notice the fact, that limestone, at many of the localities, becomes a compound rock, by taking into its composition mica, presenting much the appearance of a white granite; thus at Chester and Warrensburgh, the micaceous varieties are abundant, and they appear much like an ordinary grey granite, or a rock composed of white or grey feldspar and mica.

In addition to the uses already stated, for which this species of limestone has been employed, it has been spread like plaster upon the soil: in some instances it has evidently produced a favorable change; in others it has been doubtful, or the effects have been so slight that it was not easy to say whether any effect was produced or not.

Serpentine Marble.

Associated with primitive limestone, are extensive beds of serpentine intermixed with carbonate of lime, forming a mixture to which the above descriptive name has been applied. It is usually called *verd-antique;* but this ancient and beautiful rock is composed of materials much harder, and is more valuable.

The most important bed of serpentine marble is upon the school lot in Warrensburgh, a

polished specimen of which is in the State Collection. The serpentine in this quarry is dark green, and imbedded in a ground of grey limestone. In Johnsburgh are two or three extensive beds of the same material, but the color of the serpentine is yellowish green.

It is unnecessary to describe the different varieties which have been discovered. It is sufficient to say that they are numerous, and that the color of the marble varies from a deep green to a pale yellowish green. In general the stone is strong and sound ; and though in the air, and exposed to the weather, it is subject to disintegration, yet when defended as it would be when employed for mantel pieces and other ornamental work, it will have all the durability of granite.

The principal difficulty in fitting it for market, arises from the unequal hardness of the materials composing it. The serpentine is softer, and, in polishing, wears down more rapidly than the limestone, and hence does not acquire that lustre which the limestone receives.

Graphite, or Black Lead.

It is a matter of some moment to discover a quantity of graphite sufficiently large to meet the demands for it, and at the same time of a quality suitable to be employed for the finest drawing pencils. A quantity was discovered in Johnsburgh, on the farm of Mr. Noble, which it is believed possesses the qualities required. It occurs in irregular shaped masses, which are finely laminated, and apparently of a good quality ; but it appears to be only in small quantities. There was probably less than half a ton contained in the bed ; yet as it has not been satisfactorily explored, it is impossible to speak with confidence. In this neighborhood, it is largely distributed through the rocks ; and it is probable it may exist in beds or veins sufficiently thick to be worth working. On the farm of Mr. Noble, it was in a mass of quartz subordinate to limestone. In one of the unsettled townships, quite a large mass was discovered of the finest quality.

A beautiful form of this substance exists in Johnsburgh ; it is in six-sided tables, and perfect in form. The surfaces of these tables are marked by fine lines, indicating the rhomboid or primary form to which the species belongs. These tables are disseminated in primary limestone, and some are compound or twin crystals. This locality appears to be the only one yet discovered, which furnishes perfect crystalline forms of this substance.

Potsdam Sandstone.

An outcrop of this rock may be observed about four and a half or five miles north of Glen's-Falls. It appears as a hard quartz rock, dipping south and southwest. It rests upon gneiss : no rock, therefore, intervenes between it and the primary.

Again, under the same circumstances, at the eastern base of the Luzerne mountains, and also on the west side, particularly at the High falls at Corinth, this rock appears under its usual characters. The latter place furnishes a fine opportunity for studying the gradual change of rock from one form to another, when circumstances are favorable. At the falls,

the Hudson has forced a passage through a deep gorge between gneiss on one side, and the Potsdam sandstone on the other, by which the junction of the rocks is clearly exposed. The fall is occasioned by an uplift, which, as usual, takes place at or near the junction of the two masses. This fact, together with that of the gradual transformation of gneiss into the Potsdam sandstone, renders this locality an interesting place for examination. Even the partial development of garnet appears in the layers, after the characters of the sandstone are tolerably well formed. This fact is worth bearing in mind, as by it our conclusions may often be modified, and it is the more interesting to myself, perhaps, on account of the application it has to the rocks of the Taconic system ; for should I find in that system a limited extent of mica slate, or an alteration of the granular quartz, by which it approaches granite, I should not conclude that either of those masses are necessarily to be considered as varieties of these two rocks, any more than that the lower layers of the Potsdam sandstone at the High falls are a part of the Primary system.

At the falls, the sandstone is nearly horizontal, and is about one hundred feet thick. It forms a good building stone, and may be obtained in large flat pieces of any dimensions which may be required. At the locality north and northeast of Glen's-Falls, it is harder, and not so well adapted to the purposes of building. I was unable to find the characteristic fossil, the *Lingula* ——, at either of these localities.

This sandstone, as it exists in Warren, appears adapted to many purposes to which it has been employed in other counties, as an ordinary building stone, and probably for a fire-stone, hearths, furnaces, etc. For the latter purpose, it is much more likely to be found in the vicinity of the High falls, as it is less crystalline, or apparently less changed by proximity to the primary rocks.

We should expect that a rock so near the primary would often furnish examples of fractures and intruded rocks, dykes of greenstone, granite, etc. I have not been able in a single instance, however, to find a dyke traversing this or any of the sedimentary rocks of the county, though they are very common in the primary rocks themselves ; there are, in fact, but few instances in the whole district, although they every where approach near to the primary mass.

A fact attending the formation of this rock in Warren county may be stated, though it is not of much consequence. The lower part is a pure sandstone, to its junction with the primary ; thus, at Corinth, the conglomerate does not exist, but the rock is rather an even-grained sandstone down to its junction with the gneiss over which it lies. The fact appears to show, that wherever conglomerates are formed, they are due to local causes ; and that their period is not properly one which can be termed stormy, as has been sometimes inferred. They may, it is true, have been formed in or during a stormy period ; and so they may be entirely local, and formed upon a beach whose waves washed up the coarse materials, or near the mouth of a rapid river which bore along the larger pebbles of its shore.

The Potsdam sandstone, no where in the bounds of this county, is charged with mineral matter, neither disseminated, nor in veins. The only substance which appears in it is iron, which is only in sufficient quantity to give a brownish stain. In an economical point of view,

therefore, this rock is unimportant, so far as it is a depository of useful substances. As a rock, however, it may be employed as has been suggested above; and probably, under favorable circumstances, more extensively than I have intimated here, as it is, when easily pulverized, adapted to glass-making, furnishing a sharp-gritted sand for sawing marble, and for sand paper.

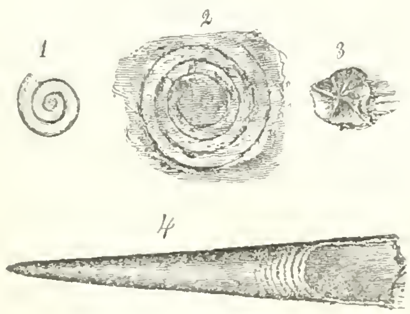
Calciferous Sandrock.

This rock may be observed at numerous places in this county. The rock which forms Diamond island in Lake George, is a good example, and is the usual form under which it appears. There are, however, several varieties of this mass, and still they possess many characters in common. It is, as would be inferred from its name, a compound rock composed of lime and sandstone or silex. About one mile northeast from the village of Glen's-Falls, it appears as an outcropping mass; it occurs at numerous places, at some of which it has been quarried for the canal locks and other purposes. It is an excellent stone for durability; and as the beds or layers are generally thick, there is no difficulty in procuring them of a large size.

This rock appears also below the falls; it forms the mass beneath the beds of marble, and may easily be recognized by the drab-colored layers which appear near the water's edge. Many of these layers might be employed for water-lime, as they are evidently impure limestones, and indicate, from the manner in which they weather, the composition required for hydraulic lime.

Some obscure univalves, together with a few other shells, may be found in the calciferous sandrock northeast of the falls, and are represented in the following cut. They are not abundant fossils, but have a wide distribution; and so far as observation has yet been extended, they have not been found in the rocks above.

53.



No. 2. Ophileta complanata.

No. 1. O. levata. This fossil I did not observe, though it belongs to this rock.

No. 3, is a plate of the head of an encrinite, very abundant in the upper part of the calciferous at Chazy.

No. 4, is the Orthoceras primigenius, a small species, found near the bridge at Fort-Plain.

But few localities furnish fossils, and the only one of much importance in the Second district is at Chazy, Clinton county, where the upper part of the rock contains them in great numbers. They will be given when the geology of that county is taken up.

The order in which the sedimentary rocks of Warren county occur is exhibited in the section which extends from Glen's-Falls four and a half or five miles northeast, to the junction of the Potsdam sandstone with the Primary system.

54.

a Primary rocks. *b* Potsdam sandstone. *c* Calciferous sandrock. *d* Trenton limestone. *e* Black marble. *g* River.

In the vicinity of *c*, two or two and a half miles from the falls, the surface has been deeply abraded and worn, and upon it many primary boulders have been deposited ; beyond this is a great accumulation of sand and boulders, principally of Potsdam sandstone, which have been derived from the mass immediately beneath. In this respect, there is a great uniformity adjacent to all our primary ranges. Near the line of junction between the two systems of rocks, we find numerous boulders arranged somewhat in regular lines, together with rounded hills composed of sand and gravel. But to return to the consideration of the calciferous sandrock, I remark that its thickness cannot be well determined at the falls, inasmuch as it is not fully disclosed ; but judging from the presence of the more siliceous layers, it may be estimated at about seventy feet.

This rock has been extensively quarried for the locks of the canal. It is found to be a durable material for this purpose. It has the advantage of other masses belonging to this group, in being a firm thick-bedded rock. It is very tough, and little liable to break ; and such is its texture, that it may be quarried with gunpowder, or receive severe concussions by other means, without producing cracks or flaws. In consequence of its composition, being a mixture of earthy matter with carbonate of lime, it weathers unequally ; the calcareous part being more rapidly acted upon, it leaves the siliceous portion standing out in a rough surface. It has in consequence an unseemly appearance before it is dressed.

The mineral substances of this rock appear to be confined to a small quantity of sulphuret of zinc, the particles of which are but little larger than peas ; they are disseminated in the rock, without showing any tendency to form veins. The locality is a mile or two northeast from Glen's-Falls.

Black Marble of Glen's-Falls.

The stratum of limestone which is here quarried, occupies a place between the Calciferous sandrock and the Trenton limestone. By means of a fracture or partial uplift of the rocks at the Falls, and by the action of the river, the three limestones have been exposed, and may be seen lying in the order indicated in the preceding section. The depth of rock exposed in this section is about sixty-five feet. On the Saratoga side, the slate which forms the upper part of the Trenton rock appears ; on the north side, this is wanting. The black marble lies under from sixty to seventy strata, varying in thickness from one inch to several feet. They all contain the fossils peculiar to the Trenton limestone in great abundance, but more obscured than at many other places. The lower part is composed of several grey layers, which are quarried for marble. Beneath these grey layers the black marble is found ; it is ten feet thick.

Although some geologists embrace this mass in the Trenton limestone, yet its fossils are rather different, and it holds a uniform place in the Champlain group, as well as a very uniform thickness ; thus, at Isle La Motte, it is, as at Glen's-Falls, immediately below the Trenton, and it has about the same thickness ; and the same remarks may be made of it as it appears at Watertown, Jefferson county. It is important to keep the two masses separate in an economical point of view, if no other ; and as it is the only important black marble of New-York, it requires this distinct notice ; for it is highly probable that this very stratum is still more continuous than has been represented. It is true, however, that at many places in the Mohawk valley, it is wanting, the Trenton reposing directly upon the Birdseye limestone.

The marble of Glen's-Falls is worked by two companies, both of which find a ready market for all that can be raised ; and it is proper to remark, that it has obtained a good reputation in New-York, Boston and Philadelphia. One of the agents informed me that shelves for mantels, seven feet and six inches long, thirteen inches wide and one and a quarter thick, had been got out ; of this size it has been sold for sixty-five cents per foot.

There are several questions to be answered, before it is safe to enter upon the marble business :

1. That relating to the expense of opening the quarry, which is by no means a trifling one.
2. That relating to the soundness of the stone in the mass ; for it is not at all difficult to procure tolerably sized specimens, free from cracks or flaws, and yet when the whole mass is examined, it may be found so fractured as to be worthless.
3. Is the marble free from flinty layers, or flinty particles ? for even when present in small masses, they not only interfere with the sawing, but to a great extent with polishing.
4. In regard to the thickness of the layers, or the mass proposed to be worked ; for unless there is a sufficient thickness in an entire bed, or if it is divided by worthless stone, the expense of raising it is so much increased, that all the profits will be absorbed. When even small defects occur in a shelf, such as checks, a seam or crack, a little flinty matter, or a fossil mineralized by calc spar, the price and value is very much reduced. It is necessary, therefore, in order that a quarry should be profitable, that it should be free generally from these defects ; but so common are they, that there are very few beds which can be worked with profit.

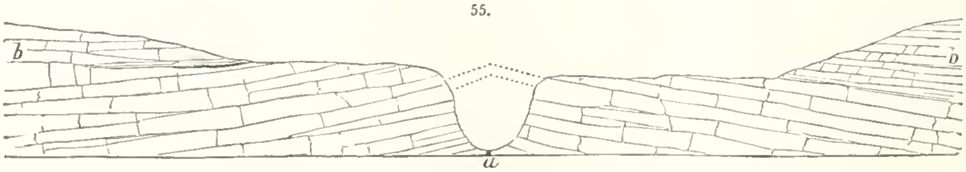
This marble is of a jet black color, of a close fine grain, and slightly crystalline. In one direction it is rather brittle, and requires to be handled with care when cut in thin tables; but these are so placed when employed for mantels and other purposes, that the strain and weight does not bear upon them in this direction so as to endanger their breaking. The planes of deposition of this marble often exhibit an interesting surface; thus, it is usually studded with projections from both the upper and under side, which interlock with each other as represented in fig. 39. Generally these projections are composed of a fibrous substance, similar in color and structure to fibrous sulphate of strontian. In the direction of those jagged places, the layers will often separate and expose a surface of several square feet. Sometimes there is interposed an extremely fine slaty matter, in which the most delicate impressions of fucoidal markings are preserved, and occasionally a small encrinite which has not yet been particularly examined.

Trenton Limestone.

The rock succeeding the black marble, is the Trenton limestone, which is well marked by its fossils, and by its lithological characters at the Falls. It has put on here its usual forms, a limestone in thin beds, with shaly layers intervening, containing the Orthis testudinaria and alternata, Isotelus gigas, Strophomena deltoidea and Trinucleus tessellatus, figures of which may be seen by turning to the geology of Jefferson county.

In Warren county, this rock can be examined only to advantage on the rocky gorge of the Hudson, and more particularly about the Falls. Passing down the river towards Baker's falls, it soon disappears beneath the Utica slate. If traced to the west, or up the river, it is also soon concealed beneath the same rock. The dip of the Trenton, therefore, above the falls, is west; while for a short distance below, it is east, an arrangement produced by a fracture and uplift which crosses the river at or near the falls, forming thereby a slight anticlinal ridge, and by which the fall is made at this place. The following section or diagram

55.



a Falls. *b b* Utica slate.

is offered in explanation of this peculiar feature in the disposition of the rocks. It was at this place that I was enabled, several years since, to determine the true position of the slates of the Hudson river series.

The uplift at Glen's-Falls is a phenomenon of some interest, when taken in connection with he changes of the same character to the east of it. Here the rocks are really but little dis-

turbed; but three miles east, at Baker's falls, they are more deranged; while still farther in this direction, the derangement has greatly increased, and has so disturbed the slates and shales, that in this district it is scarcely possible to learn their true position and relations; in fact, every geologist had misinterpreted these relations, and had fallen into error. It appears from these facts that the disturbing cause acted more and more feebly as it proceeded west, completely deranging the strata four or five miles east of Glen's-Falls; while at this place it merely lifted up the strata sufficiently to give them an inclination in two directions, and producing merely a slight fracture.

The Trenton limestone has not as yet furnished layers sufficiently thick for marble; but the general fault with it is, that it is too shaly. It is often black, fine-grained and tough; and were it thick-bedded, it would become an important rock for marble. The grey variety is, however, less shaly than the black, and frequently furnishes large blocks sufficiently sound for a building stone. It resembles, at a little distance, the grey granite; and it has this important advantage, that it works easily: it is equally durable with granite. The great abundance of building materials at Glen's-Falls, together with the peculiar advantages derived from the extension of the northern canal to the village, has made it one of the most flourishing villages in the northern counties. The waterfall, too, is one of the most important; and besides being employed in moving machinery for sawing marble, it is extensively used for lumber. For years yet to come, the supply of timber for boards will not be exhausted, being obtained from the upper branches of the Hudson, in a section of country still a wilderness. These materials are rafted down either in the spring or autumn, when the rivers are swollen so much as to pass the fords and shallows without grounding. The business of the northern canal is greatly increased by this arm of it, which was originally intended for a feeder. At this time, so greatly is it increased, that it has become one of the main channels of trade and commerce. The canal commissioners have wisely determined to keep up and improve this branch, instead of discontinuing it, as at one time was contemplated, in order to diminish the expenses in repairs.

Utica Slate.

The name of the rock which succeeds the Trenton limestone, has been already anticipated. Pursuing the course of the river for a mile or two in either direction, we find this limestone supporting a mass of black slate, which has received the designation standing at the head of this paragraph. This is well seen in ascending from the river up to the plain upon which the village of Sandy-Hill is built, or upon the banks of the river below, particularly at Baker's falls.

This rock often contains lime in sufficient quantity to effervesce with acids, but rarely sufficient sandy matter to give it a harsh feel. When recently exposed, it is dark; but after the air, moisture, etc. has acted upon it, it becomes light-colored. It is a rock which is always fragile, splits on being moistened, and is never sufficiently firm and indurated to form a roofing

slate. The slate, both above and below Glen's-Falls, contains in abundance the graptolite,* which so nearly resembles a small fern leaf, that it is usually so considered by those little acquainted with fossils.

This is the highest rock which geologically appears in Warren county; but it has an extremely limited extent, being found only along the banks of the Hudson in the vicinity of Glen's-Falls; or if it extends for some distance, it is concealed beneath the deep sand of the adjacent region.

The thickness of the slate at the south side of the river at Glen's-Falls, is about twenty feet; at the locality two miles above the falls, it is less than fifteen feet; at Sandy-Hill, three miles below, it is thirty or thirty-five. At neither of these places, therefore, does it appear in its full thickness, either from having thinned out, or from having been washed away.

Trap, or Igneous Rocks.

So limited are the rocks under this denomination, that all the important facts in relation to them may be comprised in a few words.

In the first place, there are no extensive masses of igneous rocks in the county: they are all confined to narrow dykes, which impart no very distinct features to the country; they are entirely local in their effects, and their influences as it regards other rocks are confined to one or two feet in breadth.

The most interesting dyke which fell under my notice, is at Johnsburgh, near the residence of Mr. Rosevelt. It is about two feet wide, and runs N. 55° E. It is in the usual form of trap, consisting of fine particles compacted together, with only a slight tendency to form in the mass a columnar or tabular structure. It is black or dark green, weathering to a brown as usual.

The most interesting fact connected with this dyke, and it is the only one of the kind which has fallen under my notice, is the formation of *obsidian*, at the line of contact with the gneiss in which it is embraced. The obsidian, or the part which so strongly resembles it, is perfectly compact, with a vitreous lustre and a bluish black color, and a conchoidal fracture. It is only about one inch wide on both sides of the dyke. It is to be considered as a part of the dyke, which for some cause was more perfectly pure; and in consequence of more sudden cooling, from contact with the rock, assumed the more vitreous form of obsidian. Those parts whose temperature was reduced slowly, assumed the stony aspect, with a slightly granular or crystalline structure, there being time for the particles to arrange themselves with some regularity.

Dykes of trap cross the road between Glen's-Falls and Caldwell, near the place where it is supposed Col. Williams fell in battle with the Indians. Their direction is N. 40° E.

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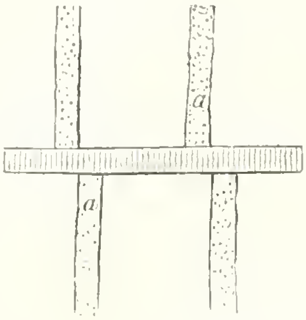
* Accompanying the graptolites, we find a very small neat bivalve, which appears to be a Posidonia; it is scarcely more than a line in diameter, and is extremely thin and very delicately striated.

Trap also occurs at the base of the first range of hills west of Glen's-Falls, towards Corinth or Luzerne. The principal rock is gneiss, but granite also appears here in irregular veins pursuing a north course. The dykes pursue a direction nearly opposite, cutting through the granitic veins as in the annexed diagram.

56.



a a Veins of granite, cut off and displaced on one side by the dyke.

We have here an illustration of the mode by which veins of iron, beds of coal, etc. are sometimes divided by an igneous rock, and moved to one side, to the right or left, or have suffered a displacement or fault, according as the veins are inclined or horizontal. The dyke at this place runs N. 70° W.

Peat.

This substance has been found in Warrensburgh, Schroon, Chester, Johnsburgh and Queensbury, and probably all parts of the county contain it: the largest beds are in Warrensburgh and Queensbury. The value which is to be attached to peat bogs arises from its employment in agriculture, in consequence of its ready conversion into manure. Its mode of employment will suggest itself to any person after a moment's reflection.

The peat is found in places once occupied by lakes, which have been filled up by the growth of water plants, trunks, leaves and roots of trees ; but particularly by the growth of the Sphagnum, a species of moss common to all wet and cool places. The depth of one of the beds of peat in Warrensburgh exceeds sixty feet, and must have been forming for seven or eight hundred years. At present, there is little probability that this substance will be used for fuel ; and still the high price of wood in most cities of the northern States seems to point to this substance as a material which might be introduced, to procure a great saving in the expenditure for fuel.

The *muck swamps*, as they are often called, are, in fact, peat beds imperfectly formed. All low wet places may be examined for peat or muck, by thrusting down a pole. The value of such localities is often immensely great, and a farmer should examine all the places upon his land, which are favorable to its production.

Peat has been employed by several farmers in Warren county, with success, for increasing the fertility of their lands. It requires to be exposed to the atmosphere and frost, before it is used for manure. An improved method of preparing it, is to expose it in heaps with barn-yard manure, or to mix with it a quantity of lime before using it, giving it an opportunity to pass into a soluble condition. As it regards this substance, I have not been particular to enter upon any estimates of its quantity or value. Such is the state of knowledge in community at the present time upon the uses of this substance, and the tests by which it may be distinguished, that I deem it unnecessary to occupy space and time in those details.

Superficial Deposits.

The section of country of which Warren county is a part, furnishes many interesting facts in relation to the currents which have swept over it. This is indicated at least by the immense number of rounded gravelly and sandy hills situated at every point where an opposing obstacle presented itself, or which could shelter it from the main power of the current, or wherever counter or eddying currents were formed.

It is unnecessary to particularize parts of the county which furnish sand and gravel hills. I may, however, remark, that in all the level parts, as the plains of Queensbury and Warrensburgh, the sand is spread out evenly; while in all the parts of the county where water-courses would be obstructed by hills or mountains, these materials are always heaped up into conical hills, unless they repose against their sides. These sand and gravel beds are not confined to the lower portion of the county, but may be found eight hundred or one thousand feet above the river at Glen's-Falls. Thus, in passing over the Luzerne mountains, they are met with upon the highest portions of the ridge.

We may divide the sand and gravel hills into three kinds, each of which is produced by a distinct cause, or by a different operation of the same cause:

The *first*, or those already spoken of, can be formed by no other agency than that of water in a large body moving with some degree of momentum.

The *second* are in the form of long ridges, composed of sand, gravel, and small rounded stones intermixed. This variety, I am satisfied, is always formed by the agency of waves. They lie along a flat section of land, which is still swampy on one or both sides, though I conceive that all vestiges of the former existence of a lake or pond may have been lost. These are produced, as I remarked, by waves, which continually wash up those materials and arrange them in a line. It is necessary to this result, that the surface should be level beyond the line where the waves cease to affect or carry up these materials, so that they may fall over on the opposite side. Under these circumstances, the waves, continually beating up the loose sand upon a stony shore, will form a ridge, sloping gradually to the water, but steep on the opposite side. These lines of gravel and sand are formed in almost every lake or pond, but generally upon that side where the waves are more constantly beating. They would appear more frequent than they do, were it not that the banks ascend too much, and rise

immediately into hills on that side only which is favorable for their formation. Instances of these ridges of which I am speaking, may be seen in Warrensburgh, on the land of Mr. Richards: On one side, in this case, there is a large peat swamp, evidently at no distant period a lake; on the other, there is a smaller marsh, which was cut off from the larger by this ridge of gravel. Another example exists at Caldwell, in the long and rather flat ridge which forms a part of the pathway leading from the village to the fort. The effect is observable here, as in the one at Warrensburgh; a portion of the lake is cut off by this barrier of sand thrown up by the waves.

The *third* variety of sand hills is found in the debris which slowly washes from the mountain side to the base. They are less conical, and are more in the form of terraces, but may be distinguished from either of the preceding by the materials of which they are formed. The latter I do not recognize so clearly in this county as in Essex; the two former, however, are not to be mistaken or overlooked. They all, however, have been confounded together under the name of *drift*, whereas it is only the first variety that can properly be classed under this name; for though the agency of water is required in each instance, yet in drift it is always supposed that it must have been in motion sufficiently powerful to transport heavy materials. As to the period of the drift, there is but little doubt that it was subsequent to the formation of the present valleys and hills, but anterior to the line of ridges spoken of under the second variety of gravel and sand hills; for it is highly probable that the cause which produced the former, would have obliterated, or so much defaced the latter, that they could not have been recognizable at the present time. Amidst the drift, in it and upon it, are the hypersthene boulders; and this leads me to remark, that the direction of it was from north to south, as it is nearly due north that the rock from which these boulders were derived exists in place.

A feature which has resulted from the transportation of drift, consists in the frequent depressions of surface below the level of the surrounding country. These depressions are basin-shaped, and usually filled with water, forming ponds or smaller bodies of water without an outlet. An example of one is furnished in Warrensburgh.

The subject of drift has many inexplicable phenomena; and it is frequently impossible to furnish answers to many of the questions which constantly rise when passing over a country like the one under consideration. Thus, in Athol there are several underground passages worn in the primitive limestone, probably by currents of water running through fissures in the rock. The mouths of these passages, or *caves* as they are usually called, are covered over by drift. In one instance, a large rounded stone, partially filling the mouth, was found, over which the sand and gravel had accumulated. These caves are over one hundred feet above the Hudson river at Athol.

A question arises, whether the river, at a former period, formed these passages; or were they formed by the current transporting the drift? Now it is more probable that the river was the agent in this case, the country having since undergone a change in its level; subsequently these passages were obstructed by gravel, as we now find them. It is no uncommon thing for underground passages to be formed by running water. We now find one extending by

means of a small stream in the west part of Chester, at a place known as the *Natural bridge*. The water at this place pours through a limestone ridge, and is constantly wearing away the rock, and increasing the extent of its underground passages. If, however, the country should be but slightly upraised, these caves would still exist, but the present stream would flow in another direction. But I leave many of these questions without attempting their solution. We have not obtained all the facts necessary for their rational exposition.

Waterfalls.

I should pass the diversified phenomena of waterfalls, with only the slight notice I have already given, were it not that they always possess more or less of a geological interest. A cause truly geological is either immediately concerned in their production as an uplift, crossing the water course; or else they are formed by the kind or condition of the masses over which the stream flows. We may go back one step further, and say that even the courses of rivers are determined by geological causes. The valleys through which they flow, have been in most cases determined by the action of those internal forces which have raised up the crust of the earth by upheavals; or, by lateral pressure, have wrinkled or folded the strata in parallel ranges, forming thereby troughs or gently sloping surfaces, down which the rivers fall as upon an inclined plane.

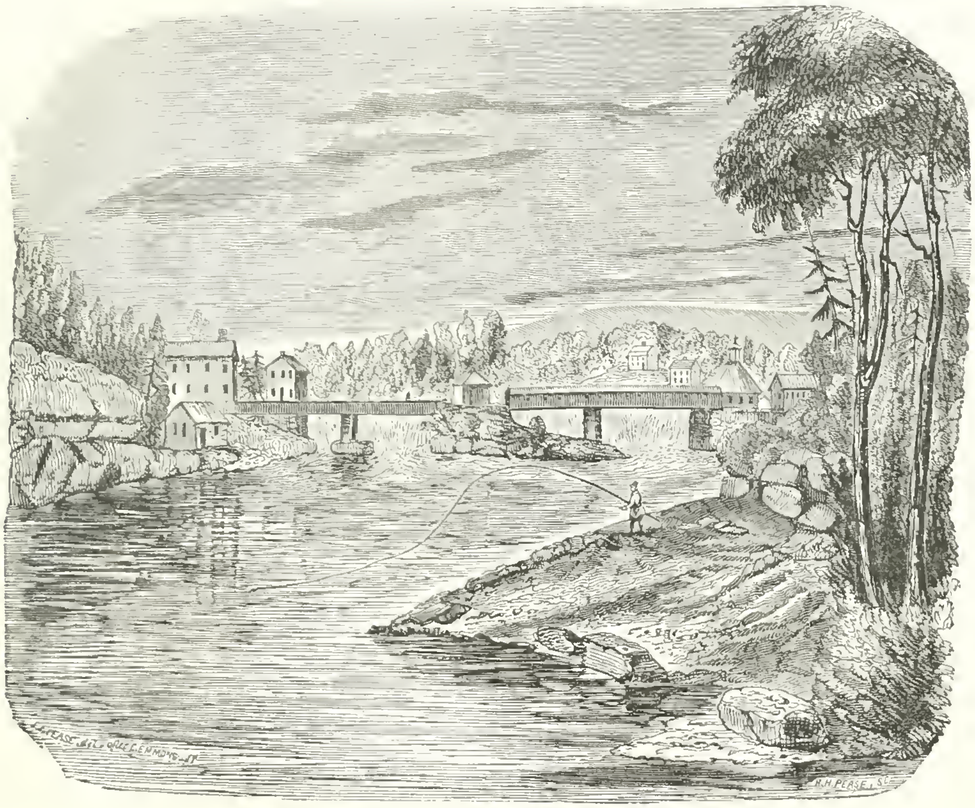
In Warren county, there are two falls well worthy of notice: that at Luzerne, called the High falls of the Hudson, and Glen's falls, both of which I have had occasion to notice. Neither of them are remarkably high, but they possess an interest aside from the space through which the water is precipitated. The river, at the former of these falls, flows for a mile through a gorge, at the junction of the Potsdam sandstone and gneiss. The force which produced the uplift, appears to have acted mostly upon the gneiss, as the layers of the sandstone are but slightly disturbed. The dip of the gneiss is N. 20° E.; and that of the sandstone, N. 20° W.

The Hudson river begins to fall rapidly just below the ferry at Jessup's landing, and flows thus for three-fourths of a mile over a rocky bottom, till within about eighty yards of the precipice: it is then driven through a narrow cleft, which is spanned by a thirteen foot plank, which serves as a bridge for the passage of footmen. There are many, however, who prefer walking half a mile, to crossing a bridge so narrow, and over a flood whose course is as swift as a racehorse, and which soon takes its leap of sixty feet over a ledge of gneiss nearly perpendicular. This fall may be seen about two miles distant, on the road leading from Glen's-Falls to Jessup's landing: it there appears like a bank of snow, and no one would suspect it to be a waterfall.

The descent over which the water falls, spreads out very wide; and when the river is low, numerous black rocks project upwards in the midst of the white foam of the cataract. The great width to which the water spreads, injures the effect as a whole; at least it appears lower in consequence; still, it is an imposing sight. Upon the east side, the gneiss rises in a perpendicular bluff nearly one hundred feet high. This mural precipice extends for some dis-

tance up the river, and adds much to the imposing effect of the fall. The fall at Luzerne is the greatest upon the Hudson; a remarkable fact, inasmuch as the river rises in the most mountainous region of the State, and descends between three and four thousand feet in one hundred and fifty miles: it then meets the tide, and admits of navigation to the ocean.

57.



View of Glen's Falls.

Glen's Falls.

Glen's falls, though not so high and imposing as those at Luzerne or Corinth, are better known, and more frequented by travellers, and those who are seeking recreation at the north during the hot season. The total descent of the river at this place is about fifty feet; but instead of falling in one unbroken sheet, it plunges into several deep gorges, which have been worn in the limestone by the river, or were occasioned by fractures which the strata suffered at the time the uplift took place. Just below the principal fall, a natural pier of solid black limestone has been spared by the flood, which serves as a building site, and to support the bridge, from which an excellent view of the falls may be obtained. The gorge below affords

a fine natural section of the strata: they have a dip first to the south, which changes to the west and northwest, but it is only slight, and the lowest strata that can be observed are only a few rods below the bridge. The above view of these falls was taken from the north side, about twenty rods below the bridge, or at that point where they are the most distinct when seen beneath it.

It will be a repetition of what has already been said, that most if not all of our falls are produced by uplifts of the rock; and I make the repetition merely to call the attention of observers more to this fact, as it brings out fully and clearly the truth of the assertion that these phenomena are principally due to geological causes. We are not aware how great and how extensive have been the operations of certain agents in the production of all such changes upon the earth, and how much they diversify the physical features of our landscapes. In order, therefore, to understand physical geography, the elements of geology, at least, become essential; as without them, we are deficient in some important items of knowledge.

The slight break in the limestone at Glen's falls is an interesting fact; for, from examination, it seems to be due rather to a wave communicated to the crust, than to a more direct application of force beneath; an oscillation, or wave which was communicated at the time the great fracture of the Hudson river slates took place. Some facts confirmatory of this view will be related when I speak of the limestone of Essex county.

58

Elevations which furnish views of distant mountains, particularly those of Essex county.

From most of the high hills about Warrensburgh, fine panoramic views may be obtained of the neighboring counties. One of the most accessible elevations is about a mile or a mile and a half south from the village of Warrensburgh; it is called Harrington's hill, or Prospect hill. It is only about nine hundred feet high, and yet it commands on all sides an extensive or wide range of vision. One of the most prominent objects is Crane's mountain in Athol. Lake George, with the Black mountains, appear in the east, and the mountains of Schroon and Ticonderoga or Crown Point, with Bluebeard or Pharaoh's mountain in the northeast; and in addition to these, a remarkably long ridge of a peculiar shape appears in the western part of Schroon. But it is to the north that the rugged features of a mountainous district appear in bold relief. Mount Marcy is the most prominent object in this direction; and from the summit of Prospect hill, the ragged ridges seem to extend away to the northeast and southwest. Several points of mountains just peer up behind the northeastern prolongation; they are the sharp conical peaks near the sources of the Ausable in Keene. The view from this hill is probably as widely extended as any in the State, except from a few of the highest summits. This hill, in consequence of being so accessible, has its importance

proportionally increased; and it would be one of the best stations from which to triangulate the northern district. Harrington's hill and Crane's mountain would form an excellent base line from which to conduct the triangulation; for from the plains of Warrensburgh, a base line nearly one mile in length can be obtained, which is a perfect level, on which to measure the distance between those two points. The length of this line is about ten miles; and from either point, the same mountains, far and near, come into view. Were it not for the errors arising from refraction, a country one hundred miles in diameter might be triangulated from these points alone. Should the State, therefore, ever enter upon the work of an accurate survey of its territory, Harrington's hill in Warrensburgh, and Crane's mountain in Athol or Johnsburgh, will form two of the most important points for carrying on a triangulation.

Simple Minerals.

They are such as are common to a primary district: Magnetic oxide of iron, pyroxene in all its varieties, hornblende, calcareous spar, zircon at Johnsburgh, associated with what appears to be sienite; pyritous iron and copper in the Brant lake district, and crystals of quartz and of graphite; boulders of labradorite are met with first in Warrensburgh, and are spread over the whole county north and west of this place; red oxide of titanium in Chester, associated with green tourmaline in primitive limestone, the two last minerals only in small quantities; sulphuret of iron in fetid limestone, crystallized under a form of twenty faces.

The zircon of Johnsburgh is quite abundant for this mineral, and is in a variety of hypersthene rock, or what has a strong resemblance to labradorite, though it is not opalescent. The crystals are from $\frac{1}{4}$ to $\frac{3}{4}$ of an inch in length; and what is quite interesting in them is, that often the crystal is quite regularly particolored; the faces, for instance, of the prism are brown, while those of the pyramid and solid angles are cream-colored. Black tourmaline, both massive and crystallized, are associated with it. The zircon is in regular four-sided prisms, terminated with a four-sided pyramid, with sometimes a replacement of the edges at the base of the pyramid.

Near the zircon locality, an interesting form of calcareous spar exists in great abundance. It is of a deep red color, in consequence of being highly charged with the oxide of iron. It might be called *ferruginous calcareous spar.* It is also of a dirty green, and associated with green talc.

Colophonite is abundant on the farm of Mr. Rosevelt, and is also found in No. 14. In the same township, scapolite and brown tourmalin exist in primitive limestone. Manganese, in small nodules, is found in a marsh near Mr. Rosevelt's, and also in dendritic impressions in the feldspar at the porcelain clay locality. Fine massive feldspar is also sufficiently abundant in Chester, to form an article of commerce.

Recapitulation.

The principal facts comprising the geology of Warren county, may be summed up thus:

1. The Primary system of rocks occupies the entire county, with the exception of Queensbury, a small field of Calciferous sandstone passing into the Birdseye limestone at Caldwell.

2. The main rock is gneiss, which runs through the county in parts of four parallel ranges of mountains, nearly from southwest to northeast, all of which reach Lake Champlain where they terminate.

3. Granite, primitive limestone and serpentine, occupy, as it regards space, a subordinate place, appearing at and around the bases of the mountains; the former of these rocks belongs to that variety which furnishes the porcelain clay, being eminently disposed to disintegration and decomposition.

4. Primitive limestone occurs in every town or township in the county, and is sufficiently pure to be used for quicklime.

5. The serpentine marble is abundant in Warrensburgh, and forms a variety, which, if taste and fashion were in its favor, would become an important article of commerce.

6. Of the New-York system of rocks, the Potsdam sandstone, Calciferous sandrock, Trenton limestone, the marble of Isle La Motte, and Utica slate, are well developed in the rocky gorge at Glen's-Falls, or in the immediate vicinity. Each of these limestones are more or less important in an economical point of view.

7. Peat exists abundantly in the county, in a state suitable to be employed as fuel or as a manure.

8. The other superficial deposits consist of sand and gravel, which, in many parts of the county, have accumulated in hills of considerable elevation, or have lodged far up upon the southern declivities of the mountains. The most important are strictly those hills which are denominated *drift*, by the best authorities of the day.

ESSEX COUNTY.

Surface and Mountain Ranges.

The county of Essex contains 1162 square miles. On the east it is bounded by Lake Champlain, along which it extends 43 miles, from thence to the west 41 miles. It embraces a large portion of that tract of country which gives origin to the Hudson river, flowing south, and to the Ausable, which flows northeast into Lake Champlain, and finally into the Gulf of the St. Lawrence. It is probably well known at the present time that it is a mountainous district, and that about the sources of the Hudson river are situated the highest lands in the State. These facts are presented in the strongest light, when I state that all the mountain chains of much importance north of the Mohawk valley, cross this county in a succession of high and sharp mountain ridges from southwest to northeast.

The first range, the Luzerne mountains, barely touches upon Essex, and terminates in Ticonderoga, in the southeast corner of the county. The second range, rising in Mayfield, passes in an oblique course through Schroon and Crown-Point, the highest part being in Schroon, whose principal elevation is called Pharaoh's or Bluebeard mountain. The third range traverses the northwest angle of Schroon, Moriah, Elizabethtown and Willsborough, where it terminates upon the lake. The fourth, which is the great chain, and which takes its origin to the north of Little-Falls, passes nearly centrally through the county, entering it at the northwest angle, and terminating upon the lake at Port Kent. The whole range is called the *Clinton chain*, and the central part, which consists of several mountains, the *Adirondack group:* this portion gives origin to the Hudson river, and is situated at the culminating point of the range, from which it declines in all directions. Mount Marcy is the highest mountain in the group, attaining an elevation of 5467 feet.

Of these several ranges, the highest peaks all fall within the bounds of Essex county. Pharaoh's mountain in Schroon, Dix peak in the West-Moriah chain, and Mount Marcy in the Adirondack group, are respectively the highest peaks in the ranges in which they are situated; and as usual in all mountain chains, there is a gradual and sometimes rapid declination from the point of highest elevation in every direction. In these ranges this is the fact, and it brings a very great proportion of the high land within the territory of one county—the county of Essex.

Exploration of the Mountains of Essex.

During the early part of the survey, I deemed it important to explore the high lands of the northern counties, particularly those of Essex. At this period nothing had been published, and probably very little was known, in relation to this mountainous tract, especially as it regarded the actual heights of the principal mountains. During the survey, many of these

mountains have been visited, and their elevations ascertained; and many facts in relation to them, not directly connected with geology, have been observed. The annual reports contain many of those observations; and as they have been frequently copied in the periodicals of the day, it appears unnecessary to repeat them here. There is, however, a communication from Prof. F. Benedict, of the University of Vermont, to myself, which it is my wish to preserve in a durable form, as it contains much important matter which is essential to all who may be engaged in barometrical observations. It is proper to remark here, that after having gone over the field myself with my barometer, and ascertained the main facts, at least approximately, I requested Mr. Benedict to review the whole subject; and this he very kindly did, without subjecting the survey to any expense except one merely nominal. The results can be relied upon, as may be seen by the steps pursued to authenticate and establish them. As Mr. Benedict's communication does not admit of division or condensation, I shall copy the whole as reported.

Measurements by Mr. Benedict.

Burlington, February 13, 1840.

Dear Sir,

Agreeably with your request, I visited at two different times, in the months of July and August last, the sources of the Hudson, Saranac and Racket rivers, with the view of determining the position of that plateau which forms the base of, and extends west of the Adirondack mountains. From the want of time and the requisite angular instruments, I was obliged to have recourse exclusively to barometrical measurements.

The instruments used at the two stations were Bunten's mountain barometers, purchased by the University of Vermont, with special reference to their adaptedness to exact observations. These instruments are syphons, with the bores of the two legs made scrupulously equal; thus avoiding erroneous corrections for capillarity. The zero point is near the middle of the scale, and the readings are from that point to the tangents of the two mercurial surfaces: the sum of these gives the observed length of the column. Such is the construction of the vernier, that it must be careless reading which would give an error of five hundredths of a millimetre, or about two thousandths of an inch. The thermometer attached is encased in the brass scale which surrounds the tube at its middle. The graduation of both the thermometer and barometer scale is very accurate. A great variety of comparative observations which I have made in connexion with Prof. G. W. Benedict, leaves no reasonable doubt of the accuracy of the graduation or uniformity of the tubes.

Of the observations made at Burlington, to synchronize with those at the superior stations, those before the sixth of July were made by Prof. G. W. Benedict, whose high standard of accuracy is well known. The elevation of this station is 235 feet above Lake Champlain, as determined and verified by the spirit level, or 325 feet above tide, estimating the elevation of Lake Champlain at 90 feet. The observations at Burlington, after the first of August, were

made by my brother, whose carefulness and skill in observing had been tested. The elevation of this station above tide was 374 feet, determined by the spirit level as above.

The table below exhibits the notes as they were taken from the instruments, with their respective calculated elevations. To convey a just idea of the agreement or discrepancy of the results, I have presented all that were made, with the exception, I think, of five or six, some of which bore evident marks of faultiness in their observations. The two numbers in the fifth column, corresponding to each date, are the upper and lower readings of the barometer, which are recorded instead of their sum, as furnishing a means of verifying the accuracy of the observations, particularly in reference to the temperature of the mercury, which is liable, without extreme care, to a false indication by the attached thermometer, of a number of degrees. I have ascertained that the condition to be satisfied in order to be assured of accuracy in this respect, for any syphon barometer, is contained in the equation

$$a - b = \mathrm{A} + \mathrm{BT} + \mathrm{C}(v + \mathrm{D});$$

in which a, b, are respectively the upper and lower readings; T, the temperature of the mercury as indicated by the attached thermometer; v, the distance of the superior mercurial surface; and A, B, C, D, coefficients which differ in different barometers, but are constant in the same. The appropriate conditions for the barometers No. 275 and No. 366, the former of which was used at Burlington, I have found to be, respectively,

$$a - b = -2{\cdot}17 + 0{\cdot}107\,\mathrm{T}, \qquad (1)$$

and

$$a' - b' = 35{\cdot}14 + 0{\cdot}107\,\mathrm{T}' - 0{\cdot}004\,(402 - a). \qquad (2)$$

These formulæ have been employed in rejecting some of the faulty observations referred to above, and, assuming the correctness of T, in correcting the elevations of Lake Colden and Mount Marcy, where the conditions expressed in (2) were not satisfactorily answered.

As is not uncommon, even with good instruments, the column of No. 275 exceeded that of No. 366 by 2·50 millimetres, which I consequently added to the sum of the upper and lower readings of the superior barometer. This difference between the columns is a mean derived from a comparison of more than one hundred sets of observations, in which care was taken to secure as great a degree of uniformity in the temperatures of the atmosphere and mercury as possible, and to exclude all causes of change in the columns which were not equally operative in each, except those depending upon peculiarities in the constructions of the instruments themselves.

Various experiments, which it is needless at present to detail, suggested the possibility that a part at least of this difference of columns might arise from a small portion of air in the summit of the tube of No. 366; and that consequently the correction above, instead of being constant, would depend upon the temperature and volume of the included air. On this hypothesis, which, however, I was prevented from verifying to the extent desired, by the loss of one of the barometers, I made the correction $(451 - a) \times 0{\cdot}021 \times (16 - \mathrm{T})$, in metres, which is additive or subtractive according as T is less or greater than 16. But to whatever

extent this correction might differ from the truth, the correction produced much more uniformity in the results of observations made at any one point than appeared without it. This correction likewise provides, to some extent at least, for any error which possibly may exist in the ordinary valuation of the effect of the temperature of the air upon the calculated elevation, or of its hygrometrical state so far as it may be indicated by this temperature, which at the superior station differs but little from T. The formula therefore used is

$$h = p + (451 - a) \times 0{\cdot}021 \times (16 - \mathrm{T}),$$

in which h represents the true difference of level between the stations in metres, p this difference according to the tables of Oltmanns, a the upper reading of the superior barometer, and T the temperature indicated by its attached thermometer.

The additional correction which I applied to the elevations of Lake Colden and Mount Marcy is

$$12\,(-m + m' + n - n'),$$

in which m, m', are the first members of the conditions (1), (2); and n, n', the second.

A slight correction for capillarity, of about three-tenths of a millimetre, I deducted from the correction 2·50 in the seven observations made during my first visit.

Oltmanns' tables have been employed in these calculations, which have furnished, in the cases in which I have compared them, the same results as those derived from Laplace's theorem. An example of this agreement appears in the calculation of the height of Mount Marcy. I have not seen the construction of these tables, but conjecture from this agreement that Laplace's theorem was made their base. Humboldt, who made his calculations according to the theorem, mentions the harmony of his results with those of the same heights by Prof. Oltmanns, and pronounces the tables of the latter to be "of the utmost precision."

Table of Barometrical Observations and Altitudes.

Elevation of Lower Saranac Lake.

		Att.	Det.	Obs.	Altitude in Eng. feet.	Deviation r m mean.
July 6, 1839.						
1 Burlington,	8h 50′ p m	20.4	15.5	751.75		
Lake, ...	" "	14.6	14.5	720.07	1528.37	+1.06
Aug. 28.						
2 Burlington,	6h 30′ p m	16.4	13.	378.30		
				378.70		
Lake, ...	6h 30′ p m	11.	10.6	379.75		
				343.54	1527.80	+0.49
3 Burlington,	7h 10′ p m	15.3	11.6	378.35		
				378.75		
Lake, ...	7h 0′ p m	10.	8.9	379.70		
				343.60	1526.41	—0.90
Aug. 29.						
4 Burlington,	5h 56′ a m	10.2	5.3	379.05		
				380.15		
Lake, ...	6h 0′ a m	4.1	3.3	380.40		
				344.90	1526.67	—0.64
Mean elevation above tide,					1527.31	

Upper Saranac Lake.

July 6.						
5 Burlington,	12h 50′ p m	20.2	18.3	755.70		
Lake, ...	1h 0′ p m	15.	15.	378.30		
				341.60	1567.58	

Stony Ponds.

July 6.						
Burlington,	10h 20′ a m	20.1	19.8	756.00		
do	11h 50′ a m	20.1	20.6	755.70		
6 Means, ...	11h 5′ a m	20.1	20.2	755.85		
Ponds, ...	11h 0′ a m	18.	18.	721.15	1536.36	

Foot of Racket Falls, about eight miles below Long Lake.

July 6.						
Burlington,	6h 20′ a m	20.1	16.	756.70		
Falls, ...	6h 15′ a m	11.	11.	721.25		
7 Falls, ...	6h 30′ a m	11.	11.	721.20		
Means, ...	6h 22′ a m	11.	11.	721.22	1538.84	

LONG LAKE, HAMILTON COUNTY.

		Att.	Det.	Obs.	Elevation above tide.	Deviation from mean
July 3.						
8 Burlington,	11h 30′ a m	23.8	23.2	750.15	1575.03	—0.93
	11h 38′ a m	22.	22.	376.10		
Lake, ...				338.60		
9 Burlington,	12h 10′ p m	23.9	24.2	749.65	1566.83	—9.13
Lake, ...	" "	22.5	22.5	376.00		
				338.50		
10 Burlington,	12h 33′ p m	24.	25.5	749.55	1566.83	—9.13
Lake, ...	12h 40′ p m	23.	23.	376.00		
				338.50		
Aug. 22.						
11 Burlington,	1h 28′ p m	27.9	26.5	377.10		
				376.20	1573.80	—2.16
Lake, ...	1h 30′ p m	25.7	24.7	378.10		
				340.30		
Aug. 24.						
12 Burlington,	2h 2′ p m	27.6	29.6	377.20		
				376.40	1587.53	+11.57
Lake, ...	2h 0′ p m	25.6	25.	378.25		
				340.50		
13 Burlington,	3h 2′ p m	28.	28.9	377.00		
				376.15	1590.17	+14.21
Lake, ...	3h 0′ p m	26.4	24.7	378.07		
				340.10		
14 Burlington,	4h 2′ p m	27.2	27.	376.70		
				376.00	1585.53	+9.57
Lake, ...	4h 0′ p m	25.2	24.4	377.80		
				340.00		
15 Burlington,	5h 7′ p m	26.7	24.	376.70		
				375.90	1579.28	+3.32
Lake, ...	5h 0′ p m	23.6	23.	377.75		
				340.00		
Aug. 20.						
16 Burlington,	1h 24′ p m	27.7	27.9	378.90		
				378.00	1573.61	—2.35
Lake, ...	1h 30′ p m	28.1	27.2	380.20		
				342.10		
17 Burlington,	1h 54′ p m	28.	27.7	378.90		
				378.00	1572.18	—3.78
Lake, ...	2h 0′ p m	27.8	26.1	380.10		
				342.10		
18 Burlington,	6h 24′ p m	28.1	23.3	378.50		
				377.40	1579.49	+3.53
Lake, ...	6h 30′ p m	23.9	23.9	379.23		
				341.60		
19 Burlington,	6h 54′ p m	28.7	23.3	378.45		
				377.40	1561.21	—14.75
Lake, ...	7h 0′ p m	20.5	21.1	379.00		
				341.80		
Mean elevation above tide, ...					1575.96	

FORKED LAKE.

		ATT.	DET.	OBS.	Elevation above tide.	Deviation from mean.
AUG. 21.						
20 Burlington,	10h 26′ p m	25.	26.1	378.40		
				377.90	1717.66	+13.14
Lake, ...	10h 30′ p m	23.5	22.4	378.10		
				340.50		
21 Burlington,	1h 26′ p m	28.6	28.6	378.20		
				377.30	1694.33	—10.19
Lake, ...	1h 30′ p m	28.	26.2	377.93		
				339.95		
AUG. 26.						
22 Burlington,	6h 36′ p m	22.	18.1	275.50		
				375.30	1694.36	—10.16
Lake, ...	6h 30′ p m	21.7	21.3	375.30		
				337.85		
23 Burlington,	7h 6′ p m	22.	18.1	375.40		
				375.30	1711.75	+7.23
Lake, ...	7h 0′ p m	21.5	21.1	375.00		
				337.60		
Mean elevation above tide,					1704.52	

ELEVATION OF RACKET ABOVE FORKED LAKE.

The observations taken with the same barometer.

AUG. 27.						
24 Forked L.	6h 25′ a m	20.	18.9	374.10		
				337.00		
Racket L.	6h 0′ a m	20.	19.5	373.65		
				336.75	26.98	
Add elevation of Racket above Forked lake,					1704.52	
Elevation of Racket lake above tide,					1731.50	

OWL'S HEAD, ABOUT FOUR MILES NORTHWEST OF THE HEAD OF LONG LAKE.

AUG. 22.						
25 Burlington,	10h 27′ a m	24.3	24.	377.50		
				377.10	2706.13	+4.52
Owl's Head,	10h 30′ a m	21.	20.5	364.10		
				326.92		

OWL'S HEAD ABOVE LONG LAKE.

With the same barometer.

AUG. 22.						
26 Long Lake,	1h 30′ p m	25.7	24.7	378.10		
				340.30		
Owl's Head,	11h 30′ a m	22.	22.2	363.90		
				326.80	1121.13	
Add elevation of Long lake above tide,					1575.96	
Elevation above tide,					2697.09	
Mean of the above results,					2701.61	—4.52

Rich Lake.

		Att.	Det.	Obs.	Elevation above tide.	Deviation from mean.
Aug. 19.						
27 Burlington,	6h 22′ p m	28.1	23.7	379.30		
				379.35	1547.20	+0.07
Lake, ...	6h 30′ p m	20.9	20.	380.60		
				343.30		
28 Burlington,	6h 52′ p m	28.1	23.9	379.30		
				379.40	1547.10	—0.05
Lake, ...	7h 0 p m	19.8	19.1	380.50		
				343.40		
Mean elevation above tide,					1547.15	

Newcomb Lake.

		Att.	Det.	Obs.	Elevation above tide.	Deviation from mean.
Aug. 19.						
Burlington,	1h 22′ p m	26.6	26.5	379.70		
				379.00		
29 Lake, ...	1h 15′ p m	23.8	22.8	379.10		
				341.55	1698.98	

Lake Sanford.

		Att.	Det.	Obs.	Elevation above tide.	Deviation from mean.
Aug. 15.						
Burlington,	6h 14 p m	23.6	19.4	380.80		
				380.40		
Burlington,	6h 44′ p m	23.1	19.3	380.70		
				380.24		
Means, ...	6h 29′ p m	23.4	19.3	380.75		
				380.32		
30 Lake, ...	6h 30′ p m	16.4	16.4	379.30		
				342.57	1719.26	+7.29
Burlington,	6h 44′ p m	23.1	19.	380.70		
				380.24		
31 Lake, ...	6h 45′ p m	16.2	16.	379.30		
				342.65	1710.58	—1.39
Burlington,	6h 44′ p m	23.1	19.	380.70		
				380.24		
Burlington,	7h 14′ p m	22.9	18.8	380.70		
				380.20		
Means, ...	6h 59′ p m	23.	18.9	380.70		
				380.22	1701.58	—10.39
32 Lake, ...	7h 0′ p m	15.9	15.5	379.40		
				342.65		
Aug. 16.						
Burlington,	3h 16′ p m	24.1	23.5	380.20		
				379.70		
33 Lake, ...	3h 30′ p m	20.2	19.7	379.25		
				342.30	1704.93	—7.04
Burlington,	6h 46′ p m	23.8	19.8	379.90		
				379.40		

Lake Sanford. — (Continued.)

		Att.	Det.	Obs.	Elevation above tide.	Deviation from mean.
Aug. 16.						
34 Lake, ...	6h 30′ p m	17.	16.9	378.50		
				341.80	1711.89	+0.08
Burlington,	7h 16′ p m	23.7	19.7	380.00		
				379.50		
35 Lake, ...	7h 0′ p m	16.3	16.4	378.45		
				341.80	1723.57	+11.60
Mean elevation above tide, ...					1711.97	
Lake Henderson.						
Aug. 19.						
36 Burlington,	1h 44′ p m	23.7	24.	381.20		
				380.70	1821.96	—1.56
Lake, ...	1h 45′ p m	22.5	22.3	379.20		
				341.75		
37 Burlington,	2h 14′ p m	24.8	23.9	381.20		
				380.70	1825.15	—1.37
Lake, ...	2h 15′ p m	23.4	22.8	379.25		
				341.60		
38 Burlington,	3h 0′ p m	23.9	23.9	381.15		
				380.50	1832.45	+5.93
Lake, ...	3h 0′ p m	24.	23.3	379.00		
				341.50		
Mean elevation above tide, ...					1826.52	
Lake Colden.						
Aug. 14.						
39 Burlington,	6h 12′ p m	23.7	19.	381.30		
				380.80	2739.50	+3.19
Lake, ...	6h 0′ p m	16.	15.8	367.35		
				329.50		
40 Burlington,	6h 42′ p m	22.7	18.9	381.20		
				380.90	2738.85	+5.52
Lake, ...	6h 45′ p m	15.2	11.8	367.30		
				329.50		
41 Burlington,	7h 0′ p m	22.5	18.	381.20		
				380.90	2730.25	+8.79
Lake, ...	7h 0′ p m	14.9	14.4	367.30		
				329.60		
Mean elevation above tide, ...					2771.53	
Adirondack Pass.						
Aug. 12.						
42 Lake Henderson, .	1h 30′ p m	15.	15.	376.55		
				340.10		
Pass, ...	11h 30′ a m	13.4	13.4	364.10		
				327.65	2817.24	

Clear Pond — Johnson's.

		Att.	Det.	Obs.	Elevation above tide.	Deviation from mean.
June 29.						
43 Burlington,	6h 5′ p m	22.5	24.	751.60	1869.52	—0.17
Pond, ...	6h 10′ p m	20.5	20.3	373.60		
				336.30		
44 Burlington,	7h 0′ p m	22.4	22.2	752.50	1877.66	+7.97
Pond, ...	7h 2′ p m	19.4	18.3	373.65		
				336.60		
45 Burlington,	6h 5 p m	22.5	24.	751.60	1865.49	—4.20
Pond, ...	6h 10′ p m	20.5	20.3	375.90		
				336.90		
46 Burlington,	7h 0′ p m	22.4	22.2	752.50	1866.08	—3.61
Pond, ...	7h 2′ p m	19.4	18.3	376.00		
				337.25		
Mean elevation above tide, ...					1869.69	

Mount Marcy.

		Att.	Det.	Obs.	Elevation above tide.	Deviation from mean.
Aug. 14.						
47 Burlington,	6h 10′ a m	18.	13.9	381.40		
				381.60	5325.29	—12.22
Mount, ...	6h 7′ a m	6.6	6.6	331.90		
				299.40		
48 Burlington,	6h 40′ a m	17.9	14.9	381.60		
				381.80		
Mount, ...	6h 30′ a m	7.	6.6	340.90		
				299.40	5339.93	+2.42
Mount, ...	7h 0′ a m	7.5	7.	335.00		
				299.50		
Means, ...	6h 45′ a m	7.2	6.8	334.93		
				299.43		
Burlington,	7h 10′ a m	18.	15.2	381.70		
				381.90		
49 Mount, ...	7h 0′ a m	7.5	7.	335.00		
				299.50	5347.31	+9.80
Mount, ...	7h 30′ a m	8.	7.5	335.05		
				299.50		
Means, ...	7h 15′ a m	7.7	7.2	335.02		
				299.50		
Mean elevation above tide, ...					5337.51	

Mean of these observations, calculated by Laplace's formula.

50	....	18.	14.7	381.57		
				381.77	5344.69	
		7.2	6.9	334.95		
				299.44		

The singular elevation of Mount Marcy distinguishes it from the other objects of calculation in the above table, and entitles it to particular consideration; more especially so, as some discrepancy exists between the measurements that have hitherto been made.

Passing over every other personal circumstance connected with my ascent, I cannot but remark, that through the characteristic liberality of the Hon. A. McIntyre, and the attentions of his agent, Mr. Porteus, I was supplied with every thing needful to my comfort as a guest, and the object of my visit materially promoted.

The following table embraces all the observations that were made during my stay on the summit. The reductions of the mercurial columns were made from a table executed by Prof. G. W. Benedict, with great care and precision, which has regard to the effect of temperature upon the brass scale, as well as upon the column of mercury.

	Times of observation.		Att. Ther.	Det. Ther.	Cor. Columns.
1	Aug. 14.	6h 7′ a m...	6.6	6.6	633.67
2	do	6h 30′ a m...	7.0	6.6	633.57
3	do	7h 0′ a m...	7.5	7.0	633.72
4	do	7h 30′ a m...	8.0	7.5	633.71
5	do	8h 0′ a m...	8.0	7.8	633.76
6	do	8h 30′ a m...	8.5	8.3	633.90
7	do	9h 0′ a m...	....	9.2	634.15
8	do	9h 30′ a m...	9.8	9.5	634.05
9	do	10h 0′ a m...	9.9	9.5	634.04
10	do	10h 30′ a m...	9.8	9.5	633.80

The wind, during the whole period, was strong and uniform from the north. Until about eight o'clock, the summit was swept by a cloud of rain and vapor. This gradually disappeared, producing rapid alternations of storm and sunshine. About ten o'clock, the sky became almost entirely clear.

It appears from the above notes, that the whole range of the column, embracing the slight but unavoidable errors of observation, is less than six-tenths of a millimetre, or less than three thousandths of an inch. The uniformity of the force and direction of the wind, is a circumstance favorable to correct results not always found on mountain peaks, which are liable to be swept by variable and conflicting currents.

From some misunderstanding in regard to time, and from not attaining the summit as early as I anticipated, only three sets of observations synchronized sufficiently to be employed. The remainder, however, answered the important purpose of verifying those that were taken.

The following are the observations made at Burlington:

	Dates.		Att. Ther.	Det. Ther.	Cor. Columns.		
1	Aug. 14.	5h 10′ a m...	18.0	13.7	760.43	Wind NE[ly.]	Cloudy.
2	do	7h 40′ a m...	18.0	13.6	760.53	do	do
3	do	6h 10′ a m...	18.0	13.9	760.73	do	do
4	do	6h 40′ a m...	17.9	14.9	761.13	do	do
5	do	7h 10′ a m...	18.0	15.2	761.33	do	do

From the little time allowed, in my first observation on the summit, for the mercury to acquire the temperature of the air, and for taking the requisite precautions, the result, 47, errs in deficiency. The elevation derived from the three sets is 5337·5 above tide, which differs from the three results only by 12·2 and 10 feet.

According to the barometrical measurement by Mr. Redfield and Prof. Emmons, as given in the New-York Geological Report of 1838, the elevation of this peak is 5,467 feet. The difference between these results is not so considerable as of *itself* to impair confidence essentially in either, and they should therefore be regarded rather in the light of mutual verifications, at least so far as concerns *barometrical* measurement. The justness of this opinion may be inferred from some remarks that may follow. If the circumstances of the two measurements were similar, in regard to the delicacy and exactness of the instruments, the positions of the stations, and the number of observations, the mean of the two should undoubtedly be taken. Not having seen a description of Mr. Redfield's barometers, I can only *conjecture* that they were of the ordinary cistern kind; and if so, the less perfect instruments.

As to the stations, Prof. Emmons had the advantage of being in nearly the same longitude, while mine differed in this respect probably fifty minutes; but they had the disadvantage in their remoteness, mine being about forty and his one hundred miles asunder. The most important circumstance in favor of my result, is the number of observations.

The only other measurement of this mountain, which has come to my knowledge, is a trigonometrical one, executed by E. F. Johnson, Esq. a distinguished civil engineer, and published Jan. 30, 1839, in his report to the New-York legislature, of his survey of a railroad from Ogdensburgh to Lake Champlain. The altitude of Mount Marcy, according to this result, is 4,907 feet; which is less than the barometrical measurements make it, by 430 to 560 feet. This discrepancy is too considerable to be altogether overlooked.

The fair presumption, as it appears to me, is, that Mr. Johnson *sought* no greater degree of accuracy than was requisite to convey a general idea of its elevation. This may be inferred from the fact that its *exact* determination was a matter of no consequence to the railroad that he was exploring, the relation between them being remote and incidental. This presumption is strengthened, moreover, from his manner of executing the measurement. His estimating the distance to the mountain from a map, instead of deriving it from an accurately established

base, connected with his acknowledged skill in his profession, furnishes abundant evidence that strict topographical accuracy was not his object.

Between what limits, then, may the trigonometrical result be depended upon? Mr. Johnson has deprived his measurement of a requisite essential to confidence as an exact operation, in leaving us totally ignorant of the position in space of his point of observation, of the distance that he actually used, and of the number and values of the angles that he observed. His estimate of distance, on the authority of the old survey records of that alpine region, is liable to an error of at least five miles. These surveys are notoriously imperfect; a fact that we might anticipate, in a country where the lands were almost absolutely valueless, and where numerous obstacles, such as local attractions, ponds and mountains, opposed the execution of a survey with even an approximation to accuracy.

Suppose now, that the angles were observed from a point near the University, at an elevation of 360 feet above tide; that the distance of the peak from this station falls between thirty-five and forty-five miles; and that its elevation above tide, according to the trigonometrical measurement, is 4907 feet. These hypotheses are sufficiently exact to answer our purpose, and from all that appears in Mr. Johnson's description of his method, the ones most favorable to his result. Imagine the elevation to consist of three parts: the first part that which is intercepted between the levels of tide, and the station at Burlington; the second part that which is intercepted between the level at Burlington, and a plane that touches the earth's surface at the point of observation; and the remainder of the elevation, the third part. These three portions, in the order above named, assuming the distance to be thirty-five miles, are 360, 817 and 3730 feet. All things else being equal, correct now a supposable error in distance of five miles, calling it forty instead of thirty-five. The first part of the elevation remains constant; the second part, varying as the square of the distance, is 1067 feet; and the third part, varying in the simple ratio of the distance, is 4263 feet. The total elevation based on this last hypothesis of distance, is 5690 feet, which exceeds my measurement by 311 feet, and the one by Mr. Redfield and Prof. Emmons by 223. An error in distance, therefore, of five miles, induces an error of elevation of 783 feet.

To show what error in Mr. Johnson's estimates would produce identity in our results, we will suppose that the distance which formed the base of his calculations was 35 miles, and that the distance necessary to make our results agree, is d. The familiar principles above alluded to furnish the equation,

$$\frac{2d^2}{3} + \frac{3730+d}{35} + 360 - 4907 = 442.$$

This gives the requisite distance d, equal to 37·8 miles. Supposing, therefore, an error in distance of only 2 miles and 8 tenths, a supposition not only possible but probable, our results would become identical.

As I have not learned the distance that Mr. Johnson actually used, it is proper to remark, that if we should assume the distances 40 and 45, instead of 35 and 40, our conclusions would not differ so much from those above, as to vitiate the argument. Using these latter

numbers, which are probably somewhat nearer the truth than the former, an error of five miles in distance would still induce an error in elevation of 718 feet.

Refraction is another cause of deviation from exactness, of which, however, I shall merely remark in this connection, that it may occasion an error of about 100 feet; and that, too, even after a correction has been applied according to the best authorities.

A discussion of the comparative merits of barometrical and angular measurements of great elevations, would prolong this communication to an unreasonable length. I shall pass over it, therefore, at present, with one or two brief remarks. The barometer and theodolite have their peculiar capabilities and defects; and the exact measurement, by either, of a mountain covered with clouds during the greatest portion of the year, and surrounded by an atmosphere subject to incessant change, demands more perfect instruments and skill in their use, than is generally apprehended.

The chief difficulty that the barometer has to contend with, and one over which it has no direct control, is a want of uniformity in the changes of atmospheric pressure in different places at corresponding times. As correct observations have been multiplied, more harmony in this respect has been detected than had formerly been supposed. Indeed, this is not the only department in which nature has been held accountable for blunders due to clumsy instruments and unskilful observers. This difficulty, without doubt, exists to such an extent as to impair confidence in single sets of observations at least, with whatever care they may have been made. The atmosphere, whether charged uniformly with vapor or not, must evidently have a strong tendency to equilibrium; and a derangement of it, within moderate distances, must consequently be transient. For this reason, a course of consecutive observations at the same station should always be taken, which will enable the observer to guard against error, either by rejecting all, or selecting those that, in this way, are shown to be worthy of confidence.

The corrections for the hygrometrical state of the atmosphere, are undoubtedly more or less imperfect; although that portion of the error which yet remains unprovided for, I apprehend, is comparatively inconsiderable. Laplace measures these effects by the temperature of the air, and observes that this hypothesis very nearly satisfies the observations that have hitherto been made. The agreement of my results, where *courses* of observations were taken, intimates with what degree of approximation I have corrected for the changes of the weather. This agreement is particularly worthy of remark in relation to Long lake, where the observations were protracted in time, and the weather singularly variable. But notwithstanding all this, I am free to admit, that these corrections are still less perfect than could be desired.

The theodolite is above the need of eulogium from any one; but, like every other human invention, it has its proper capabilities and defects. An indispensable condition to the accuracy of angular measurements, is the exact determination of a base line; a work which requires that skill, variety of delicate instruments, time and means, which, in this country, are not generally at the command of a single individual. Triangulations, embracing great extent, have been executed with astonishing precision; and the results of similar measurements, properly conducted, are entitled to the utmost confidence: on the contrary, the angular deter-

minations of high mountains have been comparatively vague. One cause for this difference, consists in the great distances at which mountains are generally observed, and the consequent smallness of the angles of elevation. In this respect, a condition is almost necessarily violated, which was scrupulously satisfied in the surveys just referred to.

The chief source of error in mountain measurements, and one which distinguishes them from horizontal ones, is refraction. This difficulty, growing out of the condition of the air, and independent, therefore, of the instrument, is analogous to the one which the barometrical method is exposed to, with this difference in favor of the latter, that the atmospheric changes going on at both stations may be detected and compared.

Refraction differs, in different countries and at different times, from one-fourteenth to one-eighth of the distance, reckoned in minutes. Such being the uncertainty as to the true path of light in low and familiar regions, it must be particularly difficult to follow it with precision through mediums of changing relations, and elevated tracts comparatively unknown. Refraction, too, depends not only upon the affections of the air, but upon the relations of the line of sight with other objects. Every one who has used the spirit level, is aware of the errors that he is exposed to, when, in clear weather, his line of collimation approaches logs and fences or the surface of the ground.

The Peak of Teneriffe, from its great elevation, and the number of times that it has been measured according to both methods by distinguished observers, is a fair practical example illustrative of the foregoing remarks, and shows that barometrical measurements are not altogether unworthy of confidence, even when compared with angular ones by the same observers. The following table as published by Humboldt, exhibits the results :

	Geometrical measurements made on land.			
By P. Feuillée,	made in	1724,	2213	toises.
The same result, modified by Bouguer,	do		2062	"
By Heberden and Cross, five operations,	do	1752,	2408	"
By Hernandez,	do	1742,	2658	"
By Borda and Pingré,	do	1771,	1742	"
By Borda,	do	1776,	1905	"
	Geometrical measurements made under sail.			
By Mannevillette,	do	1749,	2000	"
By Borda and Pingré,	do	1771,	1701	"
By Churacca,	do	1788,	2193	"
By Johnston,			2023	"
	Barometrical measurements, calculated after the formula of Laplace.			
By Feuillée and Verguin,	do	1724,	2025	"
By Borda,	do	1776,	1976	"
By Lamanon,	do	1785,	1902	"
By Cordier,	do	1803.	1920	"

In view of these measurements, Humboldt makes the following remarks:

These measures, taken at different periods, vary from 1,700 to 2,600 toises; and, what is remarkable enough, the results obtained by geometrical operations differ more from each other, than those which were found by the barometer. It has, nevertheless, been extremely wrong to cite this want of harmony as a proof of the uncertainty of all measurements of mountains. Angles, the value of which is determined by imperfect graphometers; bases that have not been levelled, or the length of which has been determined by the log; triangles that give an excessively acute angle at the summit of the mountain; heights of the barometer, without any notice taken of the temperature of the air and of the mercury; unquestionably are not means calculated to lead to accurate results. Of fourteen trigonometrical and barometrical operations above indicated, the four following only can be considered as true measurements

Borda, by trigonometry,	1905	toises.
do by means of the barometer,	1976	"
Lamanon, the same,	1902	"
Cordier, do	1920	"

Humboldt's Personal Narrative, Vol. 1 and 2, in one.

It is worthy of remark, that the mean of the five geometrical measurements made on land differs from the extremes by 422 and 493 toises, while the mean of the barometrical measurements differs from the extremes by less than 53 and 59 toises. It is remarkable, also, that Humboldt, after elaborate discussion with the details of the operations before him, should select but one geometrical result out of nine, and three barometrical ones out of four, as the most suitable to derive his mean from. It appears, also, that the range of the differences of the four measurements adopted as true ones, is 74 toises, or 3·9 per cent of the whole elevation. This justifies a remark made in an early part of this article, that the two barometrical results should be regarded as accordant; since the difference is only 2·4 per cent of the elevation of the summit above the lower station, which is more than one-third less than Humboldt considered consistent with reasonable agreement.

The measurements which I have made, although by no means so numerous as could be desired, are sufficient to fix with considerable accuracy the position of that extensive tract of table land interposed between Lakes Ontario and Champlain. Racket lake, a beautiful sheet of water in Hamilton county, embracing a surface of probably twenty or twenty-five square miles, is situated near the geographical centre of it, and may be regarded as its summit, particularly of that portion which lies west of the Adirondack mountains. The area of this tract is little, if any, less than 10,000 square miles; embracing nearly the whole of Essex, Hamilton and Warren counties, the southern and western parts of Clinton, the southern half of Franklin, the southeastern angle of St. Lawrence and northern half of Herkimer counties. These estimates are founded partly upon my own observations, and partly upon information derived from other sources, and should therefore be regarded as vague approximations only to topographical accuracy.

The natural features of this tract are prominent, and in some respects singularly interesting. The eastern division, commencing within a few miles of Lake Champlain, forms the base

of the Adirondack mountains. This mountain chain rises from the valley of the St. Lawrence, and takes a southern direction through Clinton, Franklin, Essex and Warren counties. It is then interrupted by the valley of the Mohawk, where it loses its name, although it shortly resumes a portion of its grandeur in the Catskill mountains.

In the county of Essex the chain attains its greatest elevation, in the form of an aggregation of summits rising from an elevated base of nearly 3,000 feet in height. These peaks usually affect a conical form, and exhibit some other indications of their having been subject to volcanic action at some remote geological epoch. After the able and interesting relation by Mr. Redfield of his visits to the sources of the Hudson, it would seem unnecessary for me to add, that there are probably few places in North America where Nature is invested with more magnificence and solitude than on these mountain peaks. Among the many summits which attain the perpendicular elevation of nearly a mile, Mount Marcy is probably the highest, being 5,337 feet above tide. The western limit of this alpine district is formed by Mount Emmons, about eight or ten miles south of Long lake, which apparently reaches the height of 4,000 feet; St. Anthony, (corrupted into Santanoni) a ridge of probably 5,000 feet high, between Long lake and McIntyre; and Mount Seward, perhaps 4,000 feet in height, a few miles north and in the line of Long lake, partially interposed between the Racket and Saranac rivers. The western division of this elevated tract presents a surface diversified with plains and hills, with little of it, which came under my notice, deserving the appellation of mountainous.

A striking feature observable throughout the whole extent of this high country, and one particularly interesting in an economical point of view, is the number and magnitude of its ponds and rivers, and the almost unparalleled extent of natural batteau navigation that they form. It is also a remarkable fact that these waters, although belonging in some cases to different and remote systems, are situated for more than one hundred miles in extent, in nearly the same horizontal plain. This will appear sufficiently evident from the following table, in which the distances and directions are rudely estimated from Racket lake:

				Elevation.
Racket lake,				1731 feet.
Forked lake,	8	miles	north,	1704 "
Long lake,	20	"	northwesterly,	1576 "
Upper Saranac lake,	58	"	do	1567 "
Round lake,	54	"	do	1567 "
Lower Saranac lake,	64	"	do	1527 "
Tupper's lake,	60	"	north,	1500 "
Rich lake,	30	"	northwesterly,	1547 "
Newcomb lake,	40	"	do	1699 "
Lake Sanford,	50	"	do	1712 "
Lake Henderson,	52	"	do	1826 "
Clear pond,	80	"	westerly,	1870 "

These distances are vaguely estimated by the courses of the rivers, or the most direct land routes, without seeking any greater degree of accuracy than is requisite for forming a general idea of extent. The elevations of all were taken by the barometer, except that of Tupper's lake, which is connected with my station below Racket falls by an unobstructed navigation, as I am informed, and consequently not very different from thirty or forty feet below it. These lakes are chiefly situated on the northeast quarter of this table, and that, too, which presents the most varied and mountainous surface. Judging from some examinations of my own, and from other sources worthy of confidence, the southern and western divisions are each equal in extent to this, and conform still more nearly to a horizontal plane which rests upon the surface of Racket lake.

Some general idea of the extent of natural batteau navigation may be derived from a glance at the Saranac and Racket rivers. The former of these rises near the southern line of Franklin county, in a beautiful expanse of water, of some ten or twelve miles in extent, with a coast not less than forty. A strait, of about thirty feet descent, connects this with Round lake, which is three miles in diameter. The waters are then discharged through a strait of three miles in length and about seven feet fall, into Lower Saranac lake, which is seven miles long and three or four broad. The distance, reckoned from the Indian carrying place, to the mouth of Lower lake, is about sixteen miles, and the descent forty feet, embracing only two portages, one of eighty and the other twenty rods in length. Continuing twenty miles northeasterly down the river, to Forbes', we encounter but three interruptions to the navigation, embracing an aggregate of portage of less than three miles, and a descent probably not to exceed sixty or eighty feet. The Saranac river, therefore, from Forbes', a point seven or eight miles northeast of Whiteface mountain, near the north line of Essex county, to the head of Upper Saranac lake, a distance of about forty miles, furnishes a line of batteau navigation, interrupted by an aggregate of portage of less than three miles and a half, and an elevation, to be surmounted by locks or planes, not much exceeding one hundred feet. The extent of country immediately benefited by this line, including the coasts of the lakes, and some lateral branches, can fall little short of ninety miles.

The Racket river, after communicating with Ragged lake, on the east of Racket lake, and with Forked lake on the north, pursues a northeasterly course through Long lake, and thence northwesterly to Tupper's lake. This embraces a distance of seventy or eighty miles, and a difference of level of 231 feet, of which probably not more than 175 would be found necessary to be surmounted by artificial contrivances. Four portages, equal in extent to about two miles, are the only existing impediments to a continuous passage for boats. The extent of country immediately benefited by this line, taking into account the coasts of the larger lakes, is probably not less than two hundred miles. A chain of ponds likewise extends, as I am informed, and some of which I observed from the summit of Owlshead, from near the head of Long lake, in a northerly direction, to Tupper's lake.

The close approximation of Upper Saranac lake to the navigable waters of the Racket, suggests a ready means of connecting these two systems of waters. The distance between

them is only one mile, the land but little elevated above the surface of the former, and the difference of level only between twenty and thirty feet.

Thus it appears, that by excavations equal in the aggregate to six and a half miles, and an amount of two hundred and forty feet lockage, continuous lines of navigation through, and connecting these two rivers, may be formed, equal in extent to two hundred and ten miles; and that this would be increased probably to more than three hundred, if we take into consideration the coasts of the lakes.

Respectfully yours,

FARRAND N. BENEDICT.

Valleys.

Leaving out of view the numerous defiles and long narrow depressions between the ranges of hills and mountains, there are but few which are entitled to the appellation of valleys. The mountains press and crowd generally so closely upon the shores of the lakes and rivers, that only narrow intervals remain between the banks of the latter and the steep sides of the former.

In following up the main branches of the Hudson to their sources, spaces are passed which expand into valleys, rarely exceeding two miles in width. The valleys upon the east branch are the best known, as this branch passes through the most thickly settled parts of the county. Thus from the outlet of Schroon lake, a valley extends to the north part of West-Moriah. It is bounded by high abrupt mountains on the west, on the range which terminates at Willsborough; and on the east, by the range between West-Moriah and Lake Champlain. It is intercepted on the north by the former range, between West-Moriah and Elizabethtown. It is bottomed on drift, the debris of the adjacent mountains; and high above the present bed of this branch of the Hudson, rounded stones, like those which now form its banks, are abundant. It is evident that this valley has been, at some former period, the great course through which flowed waters of much greater importance than the present stream.

Valleys apparently more extensive exist on the other branch of the Hudson; but being enveloped mostly in a wilderness, their characters are but indistinctly known. Upon the Bouquet is a wide and level plain, which has received the name of "the Valley." It might be called "the Beautiful Valley of the Bouquet." It is truly one of great beauty, when taken in connection with the high and alpine range which bounds it upon the west, and which forms the main chain of mountains of the northern counties. This valley is about four hundred feet above Lake Champlain at Westport, seven miles distant. It is also bottomed upon thick beds of clay, gravel and sand. The clay appears to be the same as that upon the lake, and I have been told that shells or fossils have been found in it. I am not able to verify this statement, but still have some confidence in it.

Passing over the mountains of Chesterfield, we reach the valley of the Ausable. Descending into it, we meet with numerous boulders of sand and gravel, which may be termed drift, many hundred feet above the sandy plains about Keeseville. In fact, upon the height of the pass, or beneath the high perpendicular walls so conspicuous on this road, thick gravel beds are not uncommon, which, from their appearance, are composed of materials transported from the north.

Though the valleys form no considerable feature in the physical geography of this county, yet channels for drainage are extremely numerous. Some of the most important have already been noticed. So numerous indeed are those channels, that they diverge in all directions from the central mass of mountains which form the Adirondack group, and convey the waters to the most distant and opposite points of our country. Thus, in the neighborhood of the sources of the Hudson, the Preston ponds, within a mile or two of some of the ramifying branches of the Adirondack river, receive and convey the waters to the Racket river, and by this channel to the St. Lawrence. The branches of the Ausable and Bouquet interlock with both branches of the Hudson, and their waters flow towards opposite points of the compass. But to finish in a few words all that is necessary upon this subject, I remark that Essex county forms a large part of the water-shed of the whole country north of the Mohawk valley. The general features of this section of country have been sufficiently described in my general account of the topography of this district, especially when taken in connection with the facts furnished by the journeys of Mr. Benedict, all of which have been given in the preceding pages.

Lakes.

There are about one hundred lakes in Essex county, most of which are small. They diversify the face of the country, and impart a greater variety to its scenery, but contribute considerably to diminish its temperature. They are not equally distributed over the country, but are collected in clusters upon the summit levels in different portions of the county. Thus, in the immediate neighborhood of Bluebeard or Mount Pharaoh in Schroon, they are exceedingly numerous; again, in the western townships, around the the Adirondack group, they are numerous, and some quite large and deep; and lastly, in the vicinity of Whiteface, we find a similar arrangement.

Most of the lakes of this county are long and narrow; and instead of occupying shallow basins scooped out of the softer materials, as earth or the ordinary slates and shales, they lie in chasms formed by uplifts and fractures in the primary rocks. That they may have been deepened by the same agents which have borne along the drift and loose materials upon the surface, is possible: for at the height of two thousand feet above tide, the rocks are scored and scratched as in the lower districts. But I am rather disposed to believe that the effect has been, generally, to fill up rather than excavate deeply into the hard rocks of this region; and if so, the tendency of those powers which have moved these materials has been to distribute them more equally, and to fill the deeper depressions. Hence, they now bear more the

character of the basins of ordinary lakes of transition or secondary country. Some have supposed that they were crateriform ; but no evidence, showing even the probability of this opinion, has ever presented itself to me, or fallen within the limits of my observations. I am induced to state the character of these lakes, and the nature of the basins which contain them, for the purpose of correcting the popular opinion in regard to them.

Drainage.

After what has been said of the slopes, valleys and mountains of this region, it is necessary to add only a few further remarks. The rivers and streams which effect the ordinary drainage of Essex county, radiate as it were from one point. The Adirondacks, which occupy the highest part of the water-shed of the north, give their waters to every point of the compass : this is strictly true as regards their final distribution. Rising, however, as many of the rivers do, from separate ranges, circumstances favor the interlockage of many of their higher branches. Thus, the several branches of the Hudson river rise many miles north of those of the Ausable ; but the directions of the main trunks are to the north, east, south and west ; namely, to the north, the Chateaugay and Salmon rivers ; to the northeast, the Saranac and Ausable rivers ; to the east, numerous small streams, which empty into Lake Champlain ; to the south, the branches of the Hudson river ; to the southwest, the East and West-Canada creeks ; to the west, the Black river ; and to the northwest, the De Grasse, Racket and St. Regis rivers. The amount of water which flows in these channels annually has never been estimated ; it is, however, immensely great. The quantity of rain which falls in the district north of the Mohawk valley, is probably much greater than upon any other part of the State of equal extent. Circumstances greatly favor condensation ; and owing to the coolness of the whole surface, evaporation takes place only to a limited extent, and hence the surplus waters flow off as has been described. Great, however, as the drainage must be, it is doubtful whether, if poured solely into the great flood of the St. Lawrence, it would add sensibly to the importance and magnitude of this river.

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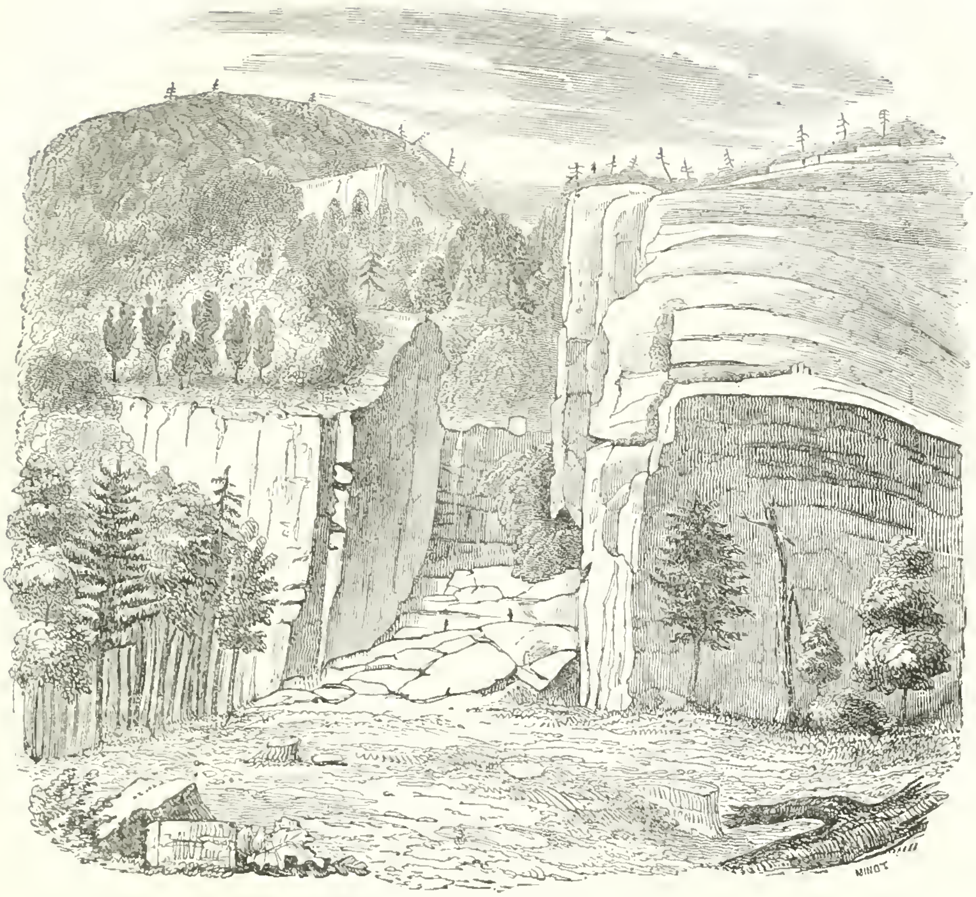

Great Trap Dyke at Avalanche Lake.

Mount McMartin, which rises boldly from Avalanche lake, is nearly bisected by an enormous dyke. The mountain may be seen from the outlet of Lake Henderson at Adirondack, bearing N. 67° E. Its distance is between five and six miles by the common route, as estimated by hunters who are familiar with the ground. Comparing its elevation with Mount Marcy and others in this group which have been measured, its height cannot be much less than five thousand feet.

The dyke, which is the most remarkable object at this place, cuts through the mountain nearly from top to bottom. At its base, where it rises up from Avalanche lake, a deep gorge has been formed by the action of a small stream, which rises some distance up the present gorge, probably in several small springs. Its depth is about one hundred feet, and it is bounded by perpendicular walls of naked rock, with numerous clefts, however, which permit

small shrubs to take root and grow. At the lower part of the mountain, the width of this gorge or chasm is about eighty feet, which is the width of the dyke, the whole of which is removed up to the walls upon each side. The materials which have been swept out of this gorge are in confused heaps below, and help to fill up the chasm between the mountains, in which the Avalanche lake is situated. Besides the immense quantity of materials from the dyke, consisting of rocks, earth and trees, a great slide, extending also from the top to the base of the mountain, contributes largely to the loose materials in this narrow pass. Great quantities of apparently pulverized vegetable matter are deposited in this lake, at least along the shores. That part of the gorge nearest the lake is steep and difficult of ascent, and also the deepest; while in ascending the more distant part, the inclination is found to be less, but the space above is crowded with large rocks which have been moved from their beds, some of which are fifty feet in length, and all have commenced their journey to the region below.

Upon the west side of Avalanche lake, Mount McIntyre rises in a mural precipice of one or two hundred feet; in the face of which, the dyke which bisects the opposite mountain distinctly appears. After going up three or four hundred feet of this latter mountain, the dyke can be traced up by the eye to near the summit of Mount McIntyre, by two parallel cracks or fissures, which appear from this distance about two feet wide. Upon this mountain there is a great deficiency of water, and there is no stream pouring down upon this face of it; and from this cause, the dyke is not broken up as on the opposite side. A small stream flowing into the cracks and fissures would break up this mass entirely; while freezing and expanding would first separate, and then force down the masses into the chasm below.

The dyke consists of the rock denominated sienite, or hornblende and granular feldspar. In the midst of the Sandford ore bed, the same rock appears, and which I found in three or four places, though the great mass of the mountain in which this ore occurs is the ordinary hypersthene rock.

The view which I have given of this dyke is strictly a map, or it is a perfect transcript of it as it was when the view was taken; but great changes are taking place from year to year, and a view which is literally correct to-day may not be so to-morrow. One half of the mural precipice which appears in the sketch, may tumble down in an instant.

Adirondack Pass.

In the midst of the mountains of Essex county, at the source of one of the main branches of the Hudson river, there is a deep narrow gorge, which has been denominated the *Adirondack Pass.* In its general character, it is in keeping with what appears on all sides where this feldspathic mass is the predominant rock, except that the scale on which this gorge has been formed is far larger and more magnificent.

This pass may be approached in two directions: First, from the Adirondack iron-works, from which it is distant about five miles. In this route, the aforesaid branch of the Hudson is followed up the whole distance, even to its source, which will be found at the very base of the

immense precipice that forms one side of the pass. The other route is from the Elba iron-works, and is merely a footpath, the course of which is followed by the assistance of marked trees. The general direction is south, and we have to thread up a branch of the Ausable near to its source. The distance on this route is about ten miles. The route which is to be preferred is certainly the shortest, or that from the Adirondack iron-works; and it is attended with as little labor to reach these iron-works, as those of Elba. In either case the whole journey has to be performed on foot, as it is impossible for any vehicle or domestic animal to reach this depression in the mountains which has been denominated as above. The mountains which are concerned in its formation, are Mount McIntyre upon the east, and the Wall-faced mountain, as it is termed by some, on the west.

The route from the Adirondack iron-works is a rapidly ascending one; that is, the rise equals about two hundred feet per mile, so that the pass is one thousand feet above the level of the iron-works, and about twenty-eight hundred feet above tide. The highest point in the pass is, however, some two or three hundred feet above the base of the perpendicular rocks.

The last half mile towards this place ascends with increasing rapidity; and on this part of the route lie numbers of immense rocks, thirty and forty feet high, scattered over the surface, some of which may be ascended, and upon their tops sufficient vegetable mould has accumulated to support a growth of trees fifty feet in height. The sides of the mountain opposite the perpendicular wall are literally strewed with these rocks; and as they are not properly boulders, they are objects of great curiosity themselves. Some of them have fallen partly over, or incline in such a position as would afford a safe shelter to a score of men. Others stand upright upon a narrow base; and we wonder how, upon such a narrow foundation, so large and towering a mass of stone could have been placed in equilibrium, especially upon a sloping surface.

But the object of greatest interest is the perpendicular precipice of a thousand feet — a naked wall of rock. The face of this wall rises from the midst of an immense mass of loose rocks, which have been falling from its side from time immemorial; and viewing them as they now lie, they seem to fill an immense cleft between the mountains; and probably the bottom of this perpendicular precipice is really as deep below, as its top is high above the surface; or at least its extent below the surface where we take the measurement, must be one-half as great as it is above. Upon the perpendicular surface the rock is naked; but where there is a fissure, or a jutting mass, small stunted shrubs find a place for establishing themselves. This wall extends one-half or three-fourths of a mile, and in no place is it less than five hundred feet perpendicular.

In viewing this great precipice, no feeling of disappointment is felt in consequence of the expectation having exceeded the reality. The conception of this imposing mass of rock necessarily falls greatly short of what is experienced when it comes to be seen. Those who visit this Pass ought by no means to be satisfied with seeing it from below: they should look down from above, and over the hanging precipice. This may be done safely, by using due caution in approaching its edge. No one, however, will attempt it without being supported,

or venture to act under the impression that they have sufficient nerve to balance themselves over such an abyss, where all objects below become indistinct, and nothing remains on which to rest the eye, and thus give certainty and precision to the movements of the muscles concerned in maintaining the equilibrium of the body.

The geological facts revealed in this great exposure of rocks, do not differ materially from those which are exhibited on all sides in this region. We are taught, however, something of the dynamics of geology, and of the inconceivable powers of those agents once active beneath the crust of the earth; for this immense mass has not only been elevated, but broken from one once continuous with it, and probably we see only a small part of that which has been thus broken and elevated. The whole rock exposed is the hypersthene; and on examining the surface as far as possible, only a few mineral substances were found. I have not observed trap dykes any where in the face of this wall, but the whole is very uniform in kind and texture.

In conclusion, I remark that I should not have occupied so much space for the purpose of describing merely a natural curiosity, were it not for the fact that probably in this country there is no object of the kind on a scale so vast and imposing as this. We look upon the Falls of Niagara with awe, and a feeling of our insignificance; but much more are we impressed with the great and the sublime, in the view of the simple naked rock of the Adirondack Pass.

Some of the most important mountains considered separately from the ranges of which they form a part.

Mount Marcy, which is the highest of the eminences in the State, is situated in the southwest corner of Keene, adjacent to the townships of Newcomb and Moriah. Its height is upwards of five thousand four hundred feet. For six or eight hundred feet beneath the summit, there are no trees. In the progress of ascending it, it will be observed that the vegetation gradually changes; the trees becoming dwarfish towards the summit, till finally all disappear. The Canada balsam, or fir, is the last; and in maintaining itself against the elements, it dwindles from a stately tree to a small vine-like shrub of six and eight inches in length. In this state, it loses almost its representative character; it ceases to reproduce itself from seed, and the noble ascending axis becomes a prostrate feeble trunk, unable to support itself in a vertical position.

This mountain extends about ten miles due north; lying, as has been before observed, obliquely to the main axis of the chain. This disposition or arrangement of the different parts of a chain is very clearly seen by comparing it with two other mountains in this region; thus Mount McMartin and Mount McIntyre lie in parallel lines with it, each of them extending from their main peaks due north and south, and each too losing themselves in those prolongations; while in the northeast and southwest directions, the range is still continued.

Though there is nothing worthy of a particular description in these mountains, aside from their height, yet their relative position deserves a passing notice. The three mountains already mentioned lie due east and west of each other, at equal distances; Mount Marcy

being the most easterly, Mount McIntyre the westerly, and Mount McMartin the central one, and each distant from the other about six miles. A little farther west of Mount McIntyre, in Franklin county, is Mount Seward, but slightly removed to the north of this westerly line, and at an elevation of nearly five thousand feet. In the disposition of all these mountains, such a regularity could not have prevailed without an established law to govern the action of the internal forces. But these laws are among the hidden things in the natural world; they are secrets which, like periodicity or periodical movements in the animal economy, evade the closest scrutiny of philosophy; and while they invite investigation, they seem to elude our grasp when almost within our reach.

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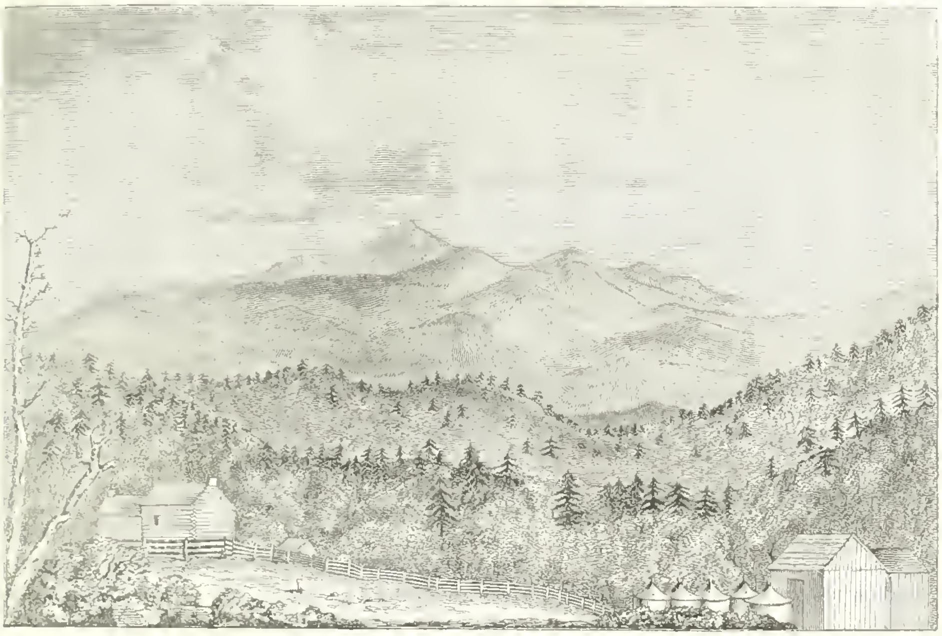


I have here introduced a view of the Adirondack group, as seen from Newcomb, of which Mount Marcy is the highest and most conspicuous member. There is one feature which this sketch exhibits worthy of some notice: it is the diversity of the northern forests; this feature is well exhibited in the drawing, and to those who are unaccustomed to scenes of the kind, it will be both novel and interesting.

Nipple-top is an insulated mountain, nearly due north of Clear pond at Johnson's, which is nine miles west of Pondsville post-office. Its appearance is really unique; the shape of the mountain is rather conical, and its top is surmounted by a remarkable projection. The ascent is steep upon all sides, but it is most accessible by following a stream which flows down its sides from near the summit upon the northeast side. A deep depression separates this mountain from the West-Moriah range. The space upon the top of the mountain is less than upon any one in the group; it is merely a sharp ridge, less than sixteen feet in length.

The scenery from its summit is of the boldest kind. The height of Nipple-top is not far from five thousand feet. It is composed of hypersthene rock, and many fine specimens of labradorite occur in rolled masses in the streams which flow down its sides. Bald mountain, upon the lake, can be clearly distinguished, and this lies nearly in a straight line between Mount Marcy and the former; and hence it forms a commanding position, and would be an important point in a trigonometric survey of the northern counties.

Bald mountain, upon the lake, is brought into view, in consequence of a depression in the West-Moriah range, directly in this line. This is an important fact, and will greatly facilitate the surveys of this region which will one day be had; and I may here observe, that such a work will be greatly aided by obtaining base lines upon the lakes when first frozen at the setting in of winter, when the surface is nearly level. A base line may be first obtained upon Lake Champlain; and afterward those errors which may arise may be corrected by subordinate lines, if necessary, upon the lakes in the interior, as some of the higher summits of the mountains are in full view from them.

Whiteface, in Wilmington, is the most northern of all the high mountains in the State. It is about five thousand feet high, and very steep and abrupt upon all sides. It rises immediately from Lake Placid, with a steep slope almost from the eastern border of the lake. This mountain is distinguished for its insulated position, and has received its name from a slide which is known to have taken place about thirty-five years ago; it commenced within a few rods of the summit, and swept the entire length of the western slope. At a distance, the mountain has a greyish white appearance towards the top. Whiteface furnishes a greater extent of surface upon its top than any other mountain of the northern counties; and hence, as a botanical field, will exceed the other summits for yielding a harvest of alpine plants. From its position, it forms another point which would be important in conducting a topographical survey. Nipple-top is nearly due south, and Mount Marcy is south about ten degrees west, in the centre of the sharp-peaked Adirondacks. To the west, a multitude of lakes in the Saranac country give a most picturesque landscape, composed as it is of dark mountains, silvery sheets of water, and fine purple skies. To the east is Lake Champlain, and the whole range of the Green mountains of Vermont, with their gentle verdant slopes diversified by woodland and cultivated fields, the whole forming a semi-panoramic view exceedingly rich and beautiful. To the north, we overlook the northern slope of the great uplift; and beyond is the level of Canada, appearing one uniform spread of forest, without a lake, or scarcely a cultivated field, and only three or four insulated blue mountains in the direction of Chambly. This mountain, it will be observed, is an interesting eminence in consequence of its position; standing out by itself from the great cluster of mountains, it overlooks on all sides the surrounding country far and near, and hence is probably the most important one to visit in the whole region. The summit forms a circular sweep for more than a mile to the north, the highest point being at the southern extremity of this ridge. On most of these mountains, the surface forming the summits is extremely limited. The extent of Nipple-top has already been spoken of: it furnishes only two or three alpine plants, though it has the altitude of Whiteface; while the latter furnishes numerous species, which will, without doubt, be increased by careful search among the rocks of its summit.

PRIMARY ROCKS OF ESSEX COUNTY.

Hypersthene Rock.

Having given the position, relations, heights and range of the mountain chains, in as much detail as seems to be essential for the right understanding of the geological features of this region, I proceed to speak of its rocks, and their distribution and mineral contents.

In taking a general survey of this field, it requires only a glance at its physiognomy, to be satisfied that the rocks belong to the primary system. This is the fact, with the exception of a narrow imperfect belt of sedimentary rocks lining the shore of Lake Champlain. The primary rocks break through the sedimentary masses, at the termination of those ranges which have been described. The individual rocks which may be enumerated as belonging to the former class, are hypersthene rock, granite, primary limestone, gneiss, hornblende, and magnetic iron ore. For reasons already given, I propose to place the latter mass among these rocks ; considering it, at least, as entitled to a place among the subordinate ones.

Of those just enumerated, hypersthene is by far the most extensive and important rock in Essex county. One of the most accessible points at which it appears, is in Schroon. In travelling north through Caldwell and Warrensburgh, boulders are first discovered to be common in the latter place, so much so as to indicate that the parent mass is not very far distant. Proceeding northwards to Schroon, it will be found that the rough hills immediately west of the village are composed of this rock ; and on examination, it will appear that the range of these hills forms the eastern flank of the great mass which prevails to the west, in the interior of the county. Their course is northeast, towards Lake Champlain, on which they finally terminate. Upon the east of these hills, the primary limestone, pursuing nearly a parallel course, forms a few hills of moderate elevation ; and probably, could we trace the latter rock, we should find it thus flanking this hypersthene chain of hills some distance to the southwest.

The most correct idea of the actual extent of the hypersthene rock in Essex county, will be obtained from a statement of the towns in which it is the predominant mass. A reference to the map will show the surface over which it is continuous. Thus, in the following towns, it forms the basis rock : Schroon, Moriah, Keene, Elizabethtown, Westport, Chesterfield, Wilmington, Lewis, Jay, Willsborough and Newcomb. In these towns it occupies a very large proportion of the surface, and in some of them the whole of it. Gneiss and primary limestone range along the eastern border in Ticonderoga and the east part of Schroon, Moriah and Westport. Bulwagga mountain, situated upon a bay of the same name, is composed wholly of gneiss. On the extreme west part of Essex, too, gneiss and primary limestone appear, skirting also the western and northwestern flanks of this great mass of unstratified rock. In Pendleton, and in the vicinity of Newcomb lake, they form, for quite a large district, the surface rock. In the central parts of the hypersthene mass, primary limestone is

less common; and when it appears, it is more in the form of narrow dykes, than where it appears upon the outsides of this formation.

But I propose to state more definitely the boundaries and extent of this important rock. Its northern termination is Trembleau point on Lake Champlain, near Port Kent. From this point, the eastern boundary line extends a little west of south, through the western part of the town of Essex, and about half way between Westport and Elizabethtown, through Moriah and the west corner of Schroon; passing on through Minerva, the northeast corner of Hamilton, and the southeast corner of Franklin county; and then passing northeast through Wilmington, and east to Trembleau point. The lines, as thus laid down, may include some other rocks along either of the borders, and may also cross the hypersthene in others. The general extent, position and boundaries, however, are as accurate as it is possible to give in a country, the larger portion of which is entirely wooded, and in which surveys have been very imperfectly conducted and performed. To New-York, this is an important tract; as it embraces the great iron region, which is surpassed by none either in this country or any other, in the amount of ore, the quality of iron it furnishes, or in the facilities for reducing it.

Hypersthene rock is composed mainly of Labrador feldspar, or *labradorite*, as it is termed. It is not a rock in which hypersthene abounds, as its name seems to imply, though it is more abundant than appears in the fresh fracture: it only comes distinctly out by weathering; its lustre of bronze then first appears; but before this change, it has much the appearance of hornblende, or some of the dark varieties of feldspar. The rock is, however, mostly Labrador feldspar. It is not easy to describe it so as to create an image of the rock itself in the mind. It is, however, a very distinct mass, and is easily recognized after an acquaintance has been formed with it.

This rock always forms steep and precipitous hills and mountains, with a tendency to conical summits and sharp rounded peaks; but there is no regularity, as I have been able to observe, in the steepness of the sides, as is the case when the mountain is underlaid or composed of stratified rocks. We certainly find perpendicular precipices on all sides; and should there be found a greater steepness on one face, as the eastern, I should be disposed to consider it as accidental, rather than as the effect of a law. In a region composed of stratified rocks, if an uplift takes place so as to produce a fracture, the steepest side is invariably that in which the fracture is made.

The conical shape of the mountains formed of this rock, has led to the popular opinion that the region is volcanic; and accounts are often related, of lights being seen, explosions heard, and sulphur smelt. But in no part of the Adirondack group is there a trace of a crater, or any sign distinctly volcanic, either ancient or modern, except in the trap dykes which are so common throughout the whole territory. It is, however, a curious fact, that Mount Etna is composed of the same variety of rock, namely, labradorite; though I am not prepared to say that this belongs to a volcanic district, any more than granite or gneiss.

It is a question which has often forced itself upon my attention, whether the Adirondacks are an older or newer system of mountains than those of New-England? In reaching the

truth of this question, the character of the rock does not seem to be of any importance: for aught we know, this species of rock may enter into the formation of mountains of all ages, as well as any primary mass. This conclusion, however, is the one to which I have arrived, independent of the direction of its range, viz. that it is newer than the mountains of New-England. I have the Hoosic and Green mountain ranges in view in this comparison. It is true that the latter has suffered a movement since the deposition of the new redsandstone; still, when the mountains of New-York are taken in connection with the tertiary of Lake Champlain, we must regard the latest movements of elevation to have occurred at a very modern period. But to determine when those movements commenced, is a difficult matter. We know that the Hudson river series is disturbed along the eastern base, or northeastern termination of some of those ranges; an event which may have happened very soon after their deposition, or at a still later period. More than one mountain range may have been elevated in the same era. Admitting that these elevatory movements are paroxysmal in a given direction, it is very possible that during a period of quiescence, or between two paroxysms, an elevatory movement may occur in another direction, and alternate states of movement and repose may be the true condition of a continent. It may turn out, however, that the forces may be more active, or remain longer quiescent, in one system than in another. I conceive, from all the facts which bear upon this subject, that however certain it may be found that elevatory movements may have taken place since the deposition of a certain mass which is disturbed, still we shall not be able to show, even relatively, when the earliest movements were imparted; for an upward movement may be slight, and not affect the masses of sediment accumulating around or at the base of a chain; it may take a much longer period to achieve a given elevation; and during repose, or the moderate action of the forces, a range in another direction may be formed. But however this may be, there appears to be one point established, namely, that the forces which uplift mountain ranges act in certain directions in preference to others.

To return for a moment to the shape of the mountains of hypersthene rock: I found them, as has been remarked, with conical summits; each main summit presents generally three peaks, the highest of which is nearly central, or there is found a *shouldered mountain*. This form is so extremely rare in the Hoosic range, that I do not remember to have seen a good example of it, yet it is the principal form where the hypersthene rock composes the mountain. In these remarks, I may be in error in attributing the form or contour of the mountain to the kind of rock of which it is composed; but I believe that none but an unstratified rock can produce precisely such forms as we find in the Adirondack group; and I attach some importance to the remarks, from the application we may sometimes make of them in forming our opinion of a mountain in the distance, whether a stratified rock forms its summit or not. Certainly none of the mountains of gneiss, and they surround the Adirondacks on all sides, ever assume the form which these uniformly present; and I believe it may be told at a distance, whether a given mountain is composed of gneiss or hypersthene, by the shape of its summit.

There is one feature in which the Adirondacks differ from the White mountains: it consists in the amount of boulders which cover the sides of the latter; for from what I learn from

Prof. Hitchcock, they are uncommonly numerous upon the White mountains, so much so as to conceal the rock, and cause great difficulty in getting sight of it: but this is by no means the case on any of the mountains of New-York; they are numerous, it is true, yet much less so than in New-Hampshire. The cause of this difference I attribute to the existence of natural joints, into which water percolates and freezes, and this results in the breaking up of the strata. The rocks of the Adirondack weather with great rapidity upon their summits; and though natural joints exist, and the rocks are broken in the same manner as upon the White hills, yet they are wanting in those divisional planes which mark the separation of strata, and hence the effect of frost is more limited upon the former than upon the latter.

The general color of the hypersthene rock is grey, light and dark intermixed, and the exterior is always lighter than the interior. The feldspar is ordinarily checked with fine seams, and sometimes the surface is powdery from disintegration. The rapid disintegration is confined to the higher part of the mountains; and the boulders, which are found scattered about the fields at their base, have little disposition to crumble.

The agricultural character of the soil formed by this rock differs in no respect from the granitic soils of other districts. It is, however, favorable to the growth of most kinds of vegetables, particularly the graminæ or grasses. The evidence of this statement is very strong; for wherever clearings are made, and timothy or herdsgrass seed happens to be scattered, it springs up and produces an extraordinary growth. This may be witnessed particularly by the road sides, or where cattle have been fed upon hay: in fact, the stalk is frequently too thick for fodder.

Uses to which the hypersthene rock may be applied.

Some of the varieties of this rock might be employed for ornamental purposes, provided it can be cut without too much expense. It is well known that all the materials which enter into its composition receive a strong polish, and many of the masses contain crystals of labradorite which opalesce. The smoke-grey seems to be best adapted to ornamental purposes, as the combination of colors are more agreeable to the eye. The strongly opalescent crystals of labradorite cannot be said to be abundant, though there is no lack of the substance, for it may be seen in almost every mass upon the surface; still, good specimens, or those which are large and free from intermixture, are by no means common, or rather are rarely to be obtained at the present time. When this region is cleared, and the surface rocks more exposed, it will undoubtedly be found more abundant. It is a great desideratum to discover some method by which granite and hypersthene rock might be cut or sawed into slabs, similar to those of marble. This material might then be brought into extensive use for tables, mantel pieces, and other ornamental and useful purposes, from which it is now excluded. No material now in use could compare with it in beauty.

Range and Extent of Granite in Essex.

This rock occupies but a small extent of territory in this county, and it occurs only in insulated beds. From the county bounding it upon the south, a small range of granite from Johnsburgh extends into Minerva. It is that variety which decomposes and forms the porcelain clay, already described under Warren county, a few beds of which have been discovered in connection with it. Granite forms a few inconsiderable cliffs in the south part of Elizabethtown. In Chesterfield, a mile and a half or two miles from Clintonville, in a southerly direction, the common grey granite appears in a high cliff resting upon primary limestone; and the line of junction between the two rocks, though irregular, is very well defined.

It is probable that this range of granite is the most extensive of any in the county; and if so, it passes through the high broken range of mountains in Chesterfield, which could not be explored without the sacrifice of more time than would have been profitable to the survey. The range of rocks between Elizabethtown and Keeseville is an indescribable mixture of granite, hornblende and gneiss, with gradations into hypersthene rock. In exploring some of the upper branches of the Hudson in the midst of the latter rock, a few small masses of flesh-colored granite were found; and it is highly probable that, in numerous places, it passes into the ordinary forms of granite. In fact, sometimes there is proof of it, in the changes which are seen; and it is not at all remarkable that passages from one kind of rock to another should take place, when we consider the circumstances under which they have been formed, and the influences to which they have been exposed.

Primary Limestone.

Commencing at the south, we find this rock entering the county in Ticonderoga, and it appears to be an extension of that mass which occurs in the vicinity of Brant lake. It is impure at its outcrop on the roadside south of the village, by intermixture with hornblende, pyroxene, quartz, etc., as is often the case with this rock. After crossing a range of gneiss on the west, we come to another belt of limestone more important than the preceding. It is the one in Schroon, already referred to when speaking of the hypersthene rock. This mass appears to be a continuation of that in Johnsburgh and Athol. Hence it pursues a northeast course, provided it be a continuous rock. It terminates on the lake at Port Henry. This range of limestone is distinguished throughout, or as far as I am acquainted with it, for its compound character, being combined or mixed in several proportions with serpentine. In some parts of the rock, the limestone and serpentine are in about equal proportions; in other instances, the limestone predominates, the serpentine gradually disappearing, till only here and there a small granule is discernible, when the limestone becomes nearly a pure rock, or free from intermixture with this substance. Whenever these two substances are commingled in the same mass, it is more free from siliceous minerals either in the form of quartz,

pyroxene or scapolite; and though phosphate of lime is very common in the primary limestone, it never occurs in this compound, and the same may be said of mica and feldspar. It is a form of rock in which we should expect also to find some of the hard and rarer minerals, as spinelle; but in those localities where serpentine is largely mixed with the limestone, I have not observed them.

This belt of primitive limestone and serpentine is about eighty rods wide. It may be found extending to twice the width in some places in the range, though it has some interruptions.

It is difficult to describe this rock in a few words, as it occurs near Port Henry. It is a pure limestone near the furnace, quite coarse and crystalline, and not so subject to decomposition as in many other places. It is suitable for quicklime, unless more siliceous than appears to the eye. The steep rock west of the public house is a mixture of yellowish serpentine and primary limestone. It has a very good appearance when polished, though the color of the serpentine is not sufficiently bright to produce the best effect.

Near the dwelling of Mr. Foot is a mixture of the same materials; the serpentine is darker, and the contrast between the limestone and serpentine is greater. But this locality furnishes an instance of apparent stratification. I say apparent; for after all, it is but the effect of a jointed structure. The mass is divided in its bed by parallel joints, by which it separates into angular blocks. This locality appears the most favorable for quarrying the rock. It is not a rock which looks fair upon the outside, but rather the contrary; the limestone is acted upon by the weather more rapidly than the serpentine, and hence the latter is left in irregular knobs, imparting to the surface a warty appearance. Situated as this rock is, upon the shore of the lake, it might be carried to market with little expense.

In the same bed, in addition to the mixtures already mentioned, I found those of coccolite and pyroxene in crystals, blood-red mica or mica which transmits a blood red light, hornblende and limestone, etc. In the midst of the bed, half a mile from the lake, is an extensive one of calcareous spar, which would probably furnish better lime than the bed at the furnace. I mention this, as I understood that some fault was found with the lime at the latter place. It contains a great abundance of graphite; and it is possible that, in this vicinity, a vein of this substance may be found. The full extent of this range of limestone southwest, I did not determine.

This rock appears again one and a half miles southwest from Moriah corners. It is an extensive bed, but is not associated with serpentine. In none of the beds observed in this neighborhood, do we find those which are suitable for marble, when not associated with serpentine. It is too coarse, with too great a tendency to friability; or else, when firm and sound, as it would be termed, it has many hard places, which interfere with the saw, and prevent the reception of a good polish.

This bed of limestone is well worth an examination, particularly at the fall above the furnace. The small stream has cut the limestone, and discloses very clearly its relations to the gneiss and hornblende which supports it on both sides. The mode in which the limestone is injected into these rocks, and the disturbances it appears to have produced upon them, are fully

disclosed at this locality; and it is scarcely necessary to add, that it furnishes many facts to support the theory of the igneous origin of limestone.

Another bed of primary limestone lies along Paradox lake in Schroon. It cannot be traced far in a southwest direction; and although it is in the range with the large beds in Johnsburgh and those of East-Moriah, I am not able to form an opinion whether there is truly a connection between these masses. I find it, however, convenient to represent a connection, or to suppose a range may exist. Observation proves that on this range beds are more frequent than upon either side, the southeast or northwest. The limestone of Schroon possesses the same general characters as elsewhere. It is quartz ore, and but very little serpentine is associated with those portions of the bed which fell under my examination. It is a locality worth farther exploration, from the occurrence of some minerals which appear in it, and which I have not observed elsewhere in the northern counties. Of these minerals, yellow chondrodite is one quite worthy of notice: it is of a bright sulphur-yellow, and forms, by contrast with the white limestone, a very pretty mineral. In the same mass, I observed small imperfect crystals of pink-colored spinelle; and a farther search might result in the discovery of larger and more perfect specimens. Yellow tourmaline, nearly transparent, occurs in the same rock, and what was still more rare, two crystals of greenish tourmaline were found, with a pale rose-colored central portion, analogous to the green and red tourmalines of the Chesterfield granite. At the locality of pyritous copper, large imperfect brown tourmalines were discovered by Mr. E. Emmons junior, one of which enclosed a crystal of zircon. From these facts, it appears that this is a region worthy of a more thorough exploration.

Another bed of limestone, worthy of a passing notice, exists in Chester, near the residence of Mr. Jonathan Griffin. Some parts of the bed are a pure limestone; others are mixed with pale green mica, a mass of which looks like feldspar and mica, or one of the varieties of granite. Some masses occur in it, composed of quartz, mica and limestone. In such facts we have strong evidence of the true origin of this species of limestone: that it is clearly a plutonic rock, scarcely admits of a doubt. In addition to these interesting relations, I found in this limestone, small quantities of grass-green tourmaline. This fact is worthy of notice, in consequence of the extreme rarity of any tourmalines in limestone, excepting those which are yellow or brown, though I had observed the pale green ones in the county of St. Lawrence some years before.

At this place, I was able to add one more mineral to the list of those associated with limestone, viz. the red oxide of titanium. It occurs in long slender brown crystals, usually in that portion of the rock which contains mica. It is necessary to remark, that these substances are so scarce, that little encouragement is offered to make expenditures for them alone. It is interesting, however, to know how prolific in simple minerals primitive limestone is in New-York. No one locality ever furnishes more than two or three in perfection; and it seems to be almost a law, that where these few exist, the others are excluded, and we must search for them at other places. This fact is, however, in accordance with all we have yet learnt in relation to such associations. It is the same in granite and gneiss and hornblende.

Brown tourmaline occurs in some other localities in a mode quite unusual: it forms, for instance, upon some smooth flat surface, as that of a crystal of scapolite, a thin arborescent pellicle, similar to a metallic deposition. Whatever it may be, or how formed, the material appears to have been in solution after the mass on which it exists had crystallized, and to have spread upon the surface while consolidating.

In the extreme west part of the town of Chester, a limestone range, in crossing a creek, forms a natural bridge. The place is principally interesting from this circumstance, and the large underground passages which have been worn out by the water. The locality is about four miles from Chester corners, on the road to Minerva.

Passing now to the northwest part of the county, we find several beds of primitive limestone, under nearly the same conditions as in the southern and eastern parts. Long pond is one of the most interesting: it is in the south part of Keene, about eight miles southeast of the Elba iron-works, and four or five west from Miller's in the same town. This bed, or rather vein, was brought to light by a slide from the mountain, which rises steeply from a small sheet of water known in the vicinity by the name of Long pond. The vein is twenty to forty feet wide, and occupies the highest part of the slide, being nearly half a mile from the pond. It rises out of the hypersthene rock, in the form of an irregular vein, or more properly a mass. It has the usual characters, but as a whole, is coarser. Some parts furnish a fine blue calcareous spar. A fact worth mentioning, is that the blue portion is confined to the surface, while the deeper situated is of a pale green; but on exposure to light, the latter also becomes blue.

This locality furnishes undoubted evidences that the limestone is an injected mass, or, in other words, a plutonic rock. The mineralogist will find at this place a rich locality of pyroxene, in all its forms and varieties. In color, it varies from the darkest green to nearly white. It is in fine glossy crystals, in perfect forms, and easily obtained by blasting the limestone. Phosphate of lime, in tolerable good crystals, may also be obtained. Another mineral, which resembles idocrase, is quite common; it is in very small crystals, but it has not been particularly examined.

This limestone furnishes no tourmaline or feldspar: it is apparently more in the character of a volcanic product, furnishing particularly those minerals which are associated with lavas, as the pyroxene, amphibole, phosphate of lime, idocrase, etc.; while in other places the same rock shows its analogy to granite, by containing tourmaline, feldspar, scapolite, etc. Where the primitive limestone furnishes the latter minerals, it is in beds more widely extended, or much larger than in the former case. It is well known to mineralogists that the narrow veins of granite are more bountiful in fine minerals than the rock itself, when it occurs as one of the principal masses over a widely extended territory; in fact, under the latter form it is eminently barren, except where it is traversed by veins of the same substance of a much later period than the principal rock. In addition to the above minerals, we have found large regular crystals of scapolite, some of which now remain attached to the rocks, and are eight inches in diameter.

The mass of limestone at Long pond belongs to one of those kinds which must necessarily be quite limited in extent. It is bounded on two sides by the hypersthene rocks, and runs south in its ascent up the mountain above the slide, where it is concealed by soil, moss, and the underbrush of the forest.

Two other beds of limestone remain, which require a mere notice of their existence : one upon Newcomb lake, which is rather impure, from intermixture with quartz, hornblende, and a poor kind of pyroxene ; and the other in Pendleton, which is a better variety, and may be employed for lime. In Chesterfield, one and a half mile southwest from Clintonville, primary limestone, associated with granite, has been discovered, of a quality suitable for lime.

The primary limestone is of little consequence to the towns and villages upon the lake, as a supply of quicklime for all purposes may be obtained from the blue limestone, as it is called, and from the birdseye, chazy, or some of the layers of the calciferous sandrock. In the western part of the county, it becomes an important rock. I have therefore been rather minute in describing it ; for where wood is so plenty, even an impure limestone may be burnt at a less expense than to transport the lime for ten or twenty miles in wagons over a bad road.

Before closing my account of the primitive limestone of Essex county, I would state the fact that it is not connected with beds of the specular oxide of iron, as in St. Lawrence county ; and that where the ore is found in this state of oxidation, it is evident that it is in consequence of a change which the protoxide has undergone.

Hornblende and Gneiss.

As rocks, it is unnecessary to consider these masses apart, however much they may differ in mineral characters. Most of the gneiss is of that variety termed *hornblendic gneiss*, in which not only hornblende replaces the mica, but the whole mass sometimes becomes hornblende. This compound flanks the hypersthene rock upon the east and southeastern sides. It enters the county from Warren, the north boundaries of which are composed mainly of it. If a line is drawn from the southwest corner of Schroon to Willsborough, the whole county east of that line is gneiss and hornblende, with the exception of the primary limestone and transition rocks. This line marks not only their boundary, but their strike or line of bearing. They are a continuation of the same rocks from Warren county, belonging to the same ranges of hills or mountains, and terminating upon Lake Champlain. All the bluffs or terminating points upon the lake south of Willsborough, upon the New-York side, are granite or gneiss.

The first range of gneiss which comes up from the south, is that which forms Bulwagga mountain. This mountain rises twelve hundred and sixty feet above the lake, with a very steep ascent, scarcely admitting the construction of a road upon its eastern side. The gneiss dips steeply to the east, at an angle of not less than fifty degrees. It is the ordinary kind, passing on the north side into hornblende : in addition to which, it forms a variety of compounds with other substances, as pyroxene, mica, etc. The mass in the immediate vicinity of the mountain is not worthy of much attention. Upon its northward side, iron pyrites is

common, but in an amorphous state; and there are also a few poor veins of iron, or iron stone, in which the ore is in a state of peroxidation.

The next mass of gneiss and hornblende reaches the lake shore about half a mile below Port Henry. An interesting place for the examination of these rocks is at the termination of the Potsdam sandstone, a few rods north of the furnace. A cove or small bay is formed by the projecting point of the sandstone, in consequence of the destruction of a large mass of primary limestone which intervenes between it and a high wall of gneiss. We find, first, the potsdam sandstone on the shore; secondly, passing round this point of sandstone, we find the limestone; and thirdly, the gneiss in a perpendicular precipice fifty or sixty feet high, against which the limestone formerly reposed. Following down the lake a little less than half a mile, we reach a place called Crag harbor. Here the gneiss and hornblende contain a vein of magnetic oxide of iron, twelve feet thick. The dip of the rocks, together with the direction of the vein, is changed from east to west, or in a direction opposite to the general inclination of the primary on the east side of the main range of mountains. This dip is, however, still found prevailing farther north, at the Walton, or as it is sometimes called the old Crown-Point ore bed.

The rock of this narrow range is more distinctly stratified than that of most of the other localities upon the lake. The limestone of Port Henry, which has already been described, appears to divide; one branch terminates a little north of the furnace, while another wider branch pursues a course still farther westerly, so that the range of gneiss which forms the rock between Port Henry and Crag harbor passes between these two branches.

The great body of gneiss of this county, however, is a wide belt which next succeeds, and of which Bald mountain forms a conspicuous part. This belt is about nine miles wide, and is an extension of the same mass which comes up from Warren county through Chester, Johnsburgh, and part of Schroon. It presents all the varieties usual in primary rocks; but what is well worthy of special examination, is the gradual amalgamation of gneiss with hypersthene rock. Contrary to the common representations in elementary works on geology, there is no passage of the latter beneath the former, so far as surface indications show; and the latter cannot therefore be said to rest upon the former, but they are imperceptibly incorporated with each other. This range pursues a northeasterly course, and terminates along the shore of the lake in steep high walls, which are often perpendicular. Such is the case at the high rocks nearly opposite Basin harbor. The main portion of this range terminates at Split-rock; or it may be called the middle portion, as a branch still more westerly appears one mile west of Westport, and finally terminates in Willsborough upon the lake.

The main range of gneiss and hornblende is important, in consequence of furnishing so many veins of iron ore: it forms a metalliferous district, and some of the veins are excellent for the quality of the iron they produce; some portions of it are well adapted for castings, while others form a tough malleable iron.

Although I have given the bounds and limits of the gneiss and hypersthene rock with as much precision as if they were strongly marked, still this is not strictly correct; for, though the latter is often well developed along this line, there are yet many examples of gneiss and

hornblende which may be found upon the west of the boundary line as given. The high range of mountains west of the valley of Schroon river, may be cited as a region where all traces of gneiss and hornblende are lost, and the range terminating in Split-rock as being wholly free from intermixture of hypersthene.

The dip of the rock forming the gneiss and hornblende district is generally east, though, as has already appeared, examples are not wanting of a dip in the opposite direction. The amount varies from fifteen to seventy or eighty degrees. The disturbances in the dip, and in other respects, appear greatest in the iron veins, or else they are there better disclosed by mining. Contortions, inversion of dip, and anticlinal axes, are not uncommon at many of the veins.

A noted point of rock terminates this range upon the lake : it is *Split-rock,* a prolongation of the range a little distance into the lake, but joined to the main land by a narrow neck. This neck is composed of a hornblende containing pyrites, in consequence of which it is brown, and often slightly porous ; but what gives origin to the term *Split-rock,* is the deep wearing away of this neck for the space of about ten feet, which cuts off half an acre of the extreme point of the range from the main land. When the water in the lake is high, this bit of land is apparently entirely separated from the main land by a deep fissure ; but in low water, the connection is still perceived to exist. The common opinion is that this small piece of land was separated by a convulsion of some kind. The fact seems to be, that no other change has taken place, than what has arisen from the decomposition of a mass containing a large amount of pyritous iron.

Magnetic Oxide of Iron.

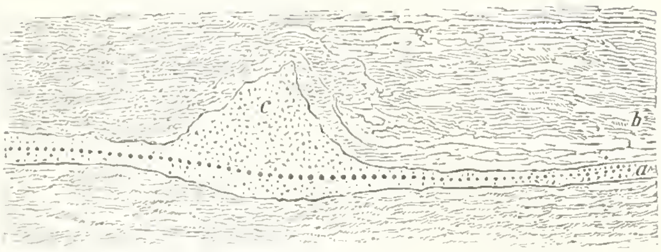
Veins which belong to gneiss and hornblende, and occupy the southeastern part of the county.

The first vein which I shall describe, is on lots Nos. 45 and 46, Paradox tract, and known as the Penfield ore bed. The ore is black, and gives throughout the whole mass the black streak, showing that it has undergone no very marked change in its state of oxidation. The lustre is bright metallic only where the fracture is fresh, and a new surface is exposed. The mass, as a whole, is dull, which is always considered an indication of a good variety of ore, and one which will reduce easily. The width is about forty feet, and its course northeast and southwest, or nearly in the direction of the line of bearing of the gneiss in which the ore is embraced. The middle part of the vein is a rich mass, and contains but a small proportion of rocky matter ; towards each side, the ore diminishes in quantity, and becomes mixed with quartz, or *lean,* as it is termed ; there being probably as much of the latter mineral, as of the ore. This pure mass of ore maintains its central position as far as the vein has been explored, a distance of from sixteen to twenty rods.

This vein is one of those in which the width varies considerably at different points : thus, from a width of forty feet, it swells out to one hundred and sixty ; the ore is lean, however,

and towards the boundaries of the vein, it is only a mere apology for a vein of ore. The annexed diagram is introduced to illustrate this feature :

61.



a, rich central part ; *b*, expanded portion ; *c*, adjacent gneiss.

The rock inclosing this vein dips to the southeast, and the vein itself dips nearly southeast.

The vein is explored along the top to the open day, and it is blasted or quarried out like any other rock. The limits of the vein north and south have not been ascertained ; it is concealed in both directions by soil, and the debris of neighboring rocks.

This vein furnishes an excellent material for bar iron, and is reduced without difficulty in the forge. The vein is very free from sulphuret of iron, and the quartz matrix forms a slag which escapes freely from the loup, without danger to its safe welding. This is the usual result when quartz is the gangue ; and it may be looked upon as a sure indication, that wherever quartz forms the gangue of a vein, the ore will work readily in the forge, and principally because of the perfect and clean separation of the slag or melted earthy materials from the iron.

In order that the value of the ores of New-York may be more extensively known and better appreciated by the community, I shall furnish some authentic testimonials of their qualities, which may be depended upon as testing their relative value and utility. With this view, I here copy an account of several experiments which were instituted by the National Government for determining the strength of the Crown-Point iron, on samples manufactured from the ore of the vein under consideration :

COMMANDANT'S OFFICE,
Navy Yard, Washington, June 13, 1829.

Sir—Agreeable to your direction, I yesterday proved the sample of iron furnished by Messrs. Penfield & Taft, and found it of superior quality; perhaps the best that has ever been proved at this Yard. As I had the ten fathoms of chain cable made for trial from iron furnished by Messrs. Holly & Co., I considered it a good opportunity to try them together, by which means I could ascertain the relative strength of each, and have a fair trial what proof they would bear. I therefore connected them by large iron, with a shackle or end link of a very large size, which I now send you. The large link parted with 384 lbs. on the lever, as stated in the accompanying report. On a second trial, Messrs. Penfield & Taft's chain parted that of Messrs. Holly & Coffin's with 418 lbs., which clearly proves that both samples are of superior iron, and that Messrs. Penfield & Taft's is best, so far as our experiments have gone.

ISAAC HULL.

To the President of the Navy Board.

Navy Yard, Washington, June 12, 1829.

Sir—In compliance with your order, we have proved four links of $1\frac{1}{2}$ inch iron from the manufactory of Messrs. Penfield & Taft, connected with 10 fathoms of the same size from Holly & Co., with $4\frac{1}{2}$ fathoms of 2 inch chain from Ridgley's works, and beg leave to report as follows: First trial, one 2 inch link broke in the solid, 384 lbs. in the scale; second trial, one $1\frac{1}{2}$ inch link of Holly's iron broke in the solid, and fractured two others considerably, with 418 lbs. in the scale, and no visible injury to Penfield's sample.

JAMES TUCKER,
JOHN JUDGE.

Com. Isaac Hull.

Navy Yard, Washington, January 20, 1829.

Sir—Agreeable to your orders, we have tried a sample of iron from the works of Penfield & Taft, Crown-Point, New-York, and find it far superior to any that has hitherto come under our notice in this Yard, both for chain cables and common purposes.

JOHN DAVIS,
JAMES TUCKER,
JOHN JUDGE.

Capt. Thomas H. Stevens.

This is to certify that I have proved the iron made from Penfield's & Taft's ore, on a powerful hydraulic machine, which I use for the purpose of trying chain cables, and find it to be superior to any iron I have heretofore used for the purpose of making chains.

JOEL JOHNSON.

New-York, June 6, 1829.
Sterling Company's Works.

From the experiments detailed in the above statements, the true value of the Penfield or Crown-Point ore may be seen; and if American iron, furnishing such tests of its strength, cannot find a market, we ought to attribute it to the determination of the public to patronize the use of foreign iron, without regard to value, strength, or any superior properties which American iron may possess.

The Penfield vein is capable of yielding a vast amount of ore; its width being at least forty feet, the central portion of which is very rich, while probably the whole vein would yield fifty per cent of ore. The walls of this vein are not well defined, a fact which would be inferred from the remarks already made; neither is the dip very distinct, but the mass of ore appears to widen on both sides as it descends into the rock. The whole extent of the vein upon the surface has never been proved, but it has been traced at least half a mile.

Another vein, or an extension of that of Penfield, has been discovered and opened half a mile south of the foregoing one. It possesses the same general qualities as the Penfield vein, and examination shows that it is equally extensive. It is free from pyrites, or other substances which are known to injure the qualities of iron, and its gangue is also a pure grey quartz.

The ores described above require, in order to prepare them for smelting, to be first pounded or stamped, and then washed, or freed from earthy matter by the magnetic separating machine: the latter mode is the one usually employed at the forges of Mr. Penfield. In this process, the pounded ore is introduced into a cylinder, about two and a half feet in diameter and five feet in length, studded with bar magnets. As the cylinder revolves, the pure ore is

attracted by the magnet, to which it adheres; it is then removed by brushes, and falls into a trough below. This mode is more expensive than washing, which consists simply in causing a stream of water to flow through the pounded ore, which washes away the light earthy matter, as quartz, hornblende, etc., while the heavy oxide remains.

I may mention another vein before leaving the neighborhood of the ore in Penfield: it is a mile northwest of the latter, and is a large vein, and furnishes an excellent ore. Still farther trial will be required before the question of its value can be satisfactorily settled. Its qualities do not apparently differ from those of the Penfield ore.

Leaving this district, and proceeding a few miles west, we find another tract in Schroon, which furnishes several veins of sufficient importance to require a brief notice.

The first and most important in this direction is a vein on the land of Mr. Harris: it is on the west side of Paradox lake. The vein is seven feet wide, and may be traced several rods upon the surface. The grain of this ore is coarse, and it is mixed with quartz, or flint, as it is usually called, and it is one of the purest ores in this neighborhood. As yet it has not been much employed at the forges, and its qualities are not well established, but apparently it is an excellent and valuable ore.

Another vein of solid ore exists on the opposite side of the lake. It is, however, only eighteen inches wide; and as it dips into the mountain, it becomes too expensive to raise for smelting. It is a very remarkable vein, being entirely a mass of magnetic oxide, without intermixture with earthy substances: it resembles a trap dyke.

Disregarding county lines, we find another tract which furnishes some ore, in Hague, and the Brant lake region in the county of Warren. The first is upon the Ellis tract: it is a vein only two feet wide; its direction is north and south, and it dips to the east; it is highly magnetic, has a fine grain, and is free from rocky matter; it is in hornblende, and is stained considerably upon the exposed surfaces with the peroxide of iron. This bed has not been tried; the kind or quality of iron which it will furnish is therefore undetermined, but there is no apparent reason why it should not be good.

Three miles north of Brant lake, in a region termed *Desolate*, is another vein ten feet thick, which may be traced upon the surface eight or ten rods: it is fine grained, and appears like good ore. The surface is stained brown with pyrites, but the quantity intermixed with the ore is only trifling. It would answer well for castings, and form a good furnace ore.

The ores of the west part of Schroon, of Brant lake, and of the Ellis tract, are not accessible to market. They are situated, however, where there is an abundance of wood and water. In these respects, they are located remarkably well. Their geological relations are much the same, being embraced in gneiss and hornblende rocks, and conforming nearly in their strike with that of the rocks to which they are subordinate.

Returning now to that portion of the county which is situated more immediately upon Lake Champlain, we find, in a circle of six or eight miles, with Port Henry as the centre, nine or ten veins, most of which are quite important, and all are capable of furnishing a large amount of ore, though they differ much in the quality of the iron which they produce.

Saxe Ore Bed.

The first which I shall notice is the Saxe ore bed, near the village in Crown-Point. It has been used formerly in the forge and furnace, but I am not informed of its reputation in the manufacture of iron. It has been abandoned for many years. It is in gneiss, mixed with a large proportion of hornblende. The point of greatest interest in this bed, is the change which the ore has suffered. It is a peroxide, but has the crystalline form and structure of the magnetic oxide ; color reddish brown, streak light red. It does not preserve the direct course of an ordinary vein, but appears in irregular masses disseminated through a hornblende rock.

There can remain scarce a doubt but that this ore is one which has gradually changed from the protoxide to the peroxide, by the absorption of an additional quantity of oxygen ; and it might be called *limonite* or *hematite*, but its structure is that of the magnetic oxide. The change in this mass of ore is, however, greater than that of another interesting vein in an adjacent county ; for here it is both internal and external ; that is, the color of the ore indicates the change it has undergone : while in the one alluded to, the internal change would not be suspected from the external appearance. In a few instances, I have observed octahedrons changed throughout to a peroxide, retaining still their forms, and in a good degree their lustre.

From all the facts which I have been able to gather, I am confident the Saxe ore will work easy in the forge or furnace, and make at the same time a good quality of iron. It is certainly agreeable to experience, that those ores which absorb oxygen, and abound in red masses or stains, prove valuable ones for reduction.

There are two or three other localities in Crown-Point and Ticonderoga, at which a red ore is obtained ; but they do not furnish it in quantities sufficient to make it an object to work for the forge or furnace. They have been employed for paints, to a limited extent.

At or near Shelving rock, the magnetic oxide occurs in connection with gneiss and primary limestone : it is in insulated masses, which are sometimes of a cylindrical shape, and four or five inches in diameter, penetrating the strata perpendicularly for two feet, and then disappearing entirely.

A much more extensive mass, in the form of a regular vein, has been opened by Mr. Foot of Port Henry, about four miles southwest from the landing. The ore is much mixed with stone at the surface ; but in the midst of the vein, we find some portions sufficiently rich in iron to be used with profit in a furnace. The surface only of this vein has been exposed ; and what one of this character will prove on being deeply opened, remains to be shown. It has much the character of a trap dyke, and might be considered a ferruginous trap, or an iron stone, though it has not that jaspery hardness which is common to those masses as they usually occur in beds of hematite.

In these veins and masses, there is only a slight disposition to crystallize ; the structure is mostly compact ; the texture is only slightly granular, and there is only a slight removal of the substance from a stony appearance. I have noticed these masses more for the bearing

they have upon the theory of the origin of the primary ore of iron, than from their importance in an economical point of view. The ferruginous dyke, or iron stone, is very probably an injected mass; or at least most individuals who have a knowledge of the phenomena of dykes and veins, would not hesitate to call this ore an instance of injected matter.

Some of the examples of the peroxide, however, have in their origin only a slight resemblance to dykes; those deep cylindrical masses, perforating a rock perpendicularly, are without doubt contemporaneous in their origin with the rock in which they are found, having been caught in the midst of the rock while in a soft state. The few localities of this kind of ore in Essex, resemble very much those in the same state of oxidation in St. Lawrence county, some of which I have noticed in my general account of the rocks of that district.

Vein at Crag Harbor.

I shall now describe several veins, whose qualities and capabilities have been established by experience.

The first is the Crag Harbor ore, situated directly upon the lake, in a cliff which almost overhangs it, and about fifty feet above the water. It is not far from half a mile below Port Henry; hence, so far as location is concerned, it is favorable, being the most accessible of all the veins in this mineral district. This vein is in hornblende, with which the ore is somewhat mixed. It is twelve feet wide, and dips southwest, or rather west, at an angle of thirty-five degrees. The rock at this place dips west thirty degrees.*

This ore is black, rather compact, or subcrystalline; it is, however, extremely tough, and difficult to reduce to a state of sufficient fineness for the forge. Burning or roasting sufficiently will do much towards overcoming this difficulty. It is strongly magnetic, though its polarity is feeble. Iron pyrites occurs in thin seams, but it does not appear to be disseminated through the mass. Black mica occurs also in the vicinity. The specific gravity of this ore is 4·729; and it yields, on analysis,

Protoxide of iron, ...	24·50
Peroxide of iron,..................	64·80
Silica, alumina, etc................	8·70
	100·00

Proportion of metallic iron, 65·23 in 100 of ore.†

This vein appears for half a mile along the lake; and though it occurs nearer the furnace than some others, yet it has not proved so profitable as those more distant. The iron from this ore is hard and brittle, and hence for many purposes it cannot be employed; yet it seems desirable that farther experiments should be made with it, for the purpose of ascertaining some mode by which the quality of the iron may be improved.

* The dip of the vein is often greater than that of the strata enclosing it.

† Dr. L. C. Beck, Report of 1837, p. 25.

About a mile west of Port Henry, another vein, similar in its geological associations to that of Crag harbor, has been opened. The ore is less pure, being mixed with more earthy matter; and some portions are highly charged with iron pyrites, so much so as to require roasting before they can be used for castings. It is more friable, or softer, as it is termed, and may be reduced readily to that form which is necessary before it is put into the furnace. This vein does not appear at all adapted to the manufacture of bar iron; but I was informed by a gentleman of undoubted experience, that it is the best vein in the neighborhood for the furnace, and that it formed the smoothest castings of any which had been used at the furnace while the late Maj. Daliba carried on the business.

Walton or Old Crown-Point Vein.

One mile and a half from Cedar point, is the Walton vein, the oldest one which has been wrought in this vicinity, having been opened more than half a century. It has an open exposure to the east, being situated at the base of a low ridge running nearly northeast. This vein is eleven feet wide, and has been explored for half a mile to the depth of thirty feet. It dips with the strata thirty degrees to the west, with a strike corresponding to that of the gneiss in which it is enclosed. It is black, friable, or easily reduced to that mechanical state of fineness which is essential to its easy reduction in the forge or furnace. It is explored to the open day, and the wall of gneiss upon the upper side is supported by columns of ore left *in situ*. The line of demarkation between the ore and rock is perfectly distinct, for the whole distance exposed. The iron made of this ore is of a good quality, having the requisite degree of toughness for all ordinary purposes.

Associated with this vein, is an interesting variety of green feldspar: it seems to be labradorite, but at the first inspection it might be mistaken for actinolite, though its cleavages are those of feldspar.

This ore occurs in a form usually termed a *bed*, or the walls of the vein correspond to the surfaces of the strata. In its general characters, it is clearly an instance of a vein, being enclosed within parallel walls with a definite direction.

Sanford Vein.

This is about four miles northwest of Port Henry, having the same geological relations as the vein last described. Its characters are, however, quite different: its colors incline to brown rather than black, and this is not be attributed to the absorption of oxygen, but to the intermixture of a brownish mineral which I conceive to be phosphate of lime. The ore is easily raised, and is a very large mass, but it has less the character of a distinct vein than the preceding. It is friable, or feebly coherent; and so far as this condition exists, it is one favorable for exploration. The dip of the mass is southwest, and it lies in strata or layers, rendered distinct by change of texture, or the intervention of some foreign mineral substance. It is easily

worked, but the iron is too hard and brittle for some purposes, though for ordinary ends it may be called a medium ore. It has only a distant resemblance to the Arnold ore of Peru. The properties of the iron are undoubtedly due to a brown granular mineral, which is disseminated through the whole vein, so far as it has been exposed. Very handsome fibrous actinolite occurs in thin seams in the vein, but no other substance worthy of note has been discovered in it. Even iron pyrites, so common in most veins, appears to be wanting here. It appeared very strange to bloomers, that an ore which looked so well, and was so soft and easy to reduce, should make an iron of a poor quality; and they were little disposed to believe that the brownish substance was the cause of the mischief, when I pointed it out to them. Mixed as the phosphate is with this ore, there appears to be no method by which it can be removed; and the probability is that it may be still employed, yet only for the most ordinary purposes. There may not, however, be so much objection to this ore for stoves and other common castings.

Barnum Vein.

About half a mile west of the Sanford ore, is a very distinct vein, known in the vicinity as the Barnum vein or bed. The vein is about seven feet thick, and dips west about thirty degrees, or corresponds in dip and strike to the layers of the hornblende in which it is embraced. The ore is black, soft and friable, and free from foreign substances which are known to injure the quality of iron. It is said also to work well in the forge.

This vein, principally on account of the state of trade, or the small demand for American iron, has not been in use since the survey commenced; and in consequence of water which has collected in the excavations, I was unable to make those examinations which are requisite for a full determination of its value. I was, however, favorably impressed as it regarded the quality and quantity of the ore.

Hall's Vein.

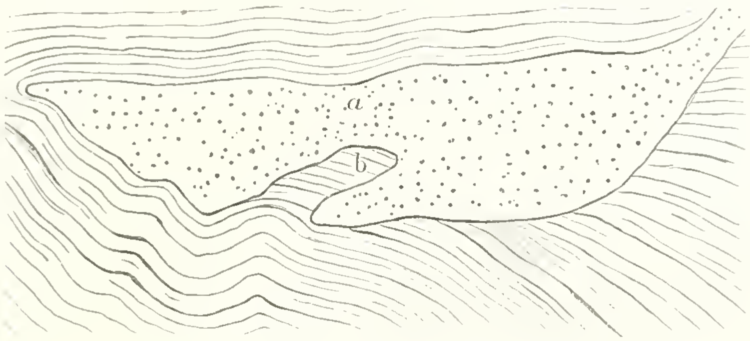
I have now to describe several veins of an excellent quality, situated five or six miles from Port Henry, or about three-fourths of a mile north of the Barnum vein. Although the rock is the same as in the veins already described, yet the ore is associated with quartz, and the state of aggregation is the most favorable for the production of iron.

There are other circumstances which render these veins more interesting to the geologist. Many of the openings into them disclose very decided evidences of mechanical force, or disturbances which appear to be connected with effects produced by the upward projection of the veins themselves. Changes in the amount and direction of the dip, the compression which the veins have suffered at some points, the irregularities in the walls, etc., are some of the phenomena brought to light in the working of these veins. The preceding ones, or those which I have already noticed, are exceedingly uniform in the amount of their dip, in the perfect regularity of their strike, in their thickness, and in the absence of contortions, or those changes which indicate mechanical violence. It will be my object to notice some of

the most remarkable of these phenomena. Many facts of an interesting nature, and having an important bearing on the origin of the magnetic oxide, will, without doubt, be brought to light in the farther exploration of several of these veins; and I am particular in pointing to this locality, as one which will be peculiarly interesting to American geologists. As yet the phenomena connected with veins of iron have not received that attention which they deserve in a geological point of view. They have been visited more for mineralogical purposes, than for the study and observation of the peculiar phenomena which attend them.

The Hall vein is the first which I shall notice; it is five feet wide, and dips west at an angle varying from fifteen to twenty degrees. The vein does not correspond in dip to that of the strata; it ranges, however, about east-northeast. The ore is black, but not bright; it is mixed with grey quartz, and a large proportion requires separating, or washing. The walls, or rather the roof, is smoothed and striated by pressure and friction, or it exhibits that appearance termed *slickensides* — an appearance produced by the forcible propulsion of a very heavy body across a moderately even surface. The wall which is most exposed projects in upon the vein, exhibiting an imperfect serrated appearance, as in the following cut:

62.



a, vein of ore; *b*. rock projecting in upon the vein.

Those masses of rock which thus project in upon the vein, are frequently quite large; however, they disappear in the progress of the work.

The roof or superior wall in the Hall vein is quite irregular, and it is possible that it is not the true wall. If this conjecture is true, the rock will finally disappear, and another mass of ore will be found on the west side. In fact, at some of the openings along the vein, such a result appears very likely to follow; as on exploration a few feet west, ore is found which appears to be separated from what seems to be the main vein, by a layer of rock.

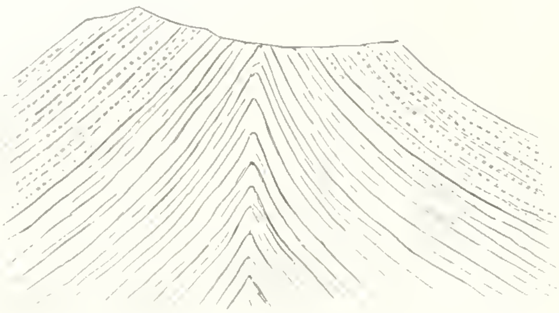
It is sometimes found that layers of rock project nearly across the vein, in a manner represented in fig. 62.

This section of the vein is exposed at the most southern point where it was opened. I was told that at first those masses of rock projected entirely across the vein; and that at the depth of five feet, they had diminished in length nearly one-half; so that there is very little doubt

but the entire vein, at the depth of only ten feet, will be free from stony matter at this particular point. It is difficult to account for these projecting masses, except on the supposition that the ore has been forced between the strata, and, in some instances, has broken them off and otherwise displaced them. It is, however, a matter of more importance to know, in the progress of mining, that in regular veins they will disappear; and that such difficulties are more common at the first opening of a vein, or when near the surface, than at great depths.

Another phenomenon exhibited at one of the smaller openings of the Hall vein, is the folding of the strata. The rock is gneiss, and distinctly stratified; and the ore, together with the rock, exhibits the appearance represented in the cut:

63.



The apex, point or plane of the folding is removed. It is clear, from an inspection, that the ore on each side of the axis belongs to the same vein or mass. The ore in this place occurs in alternating layers with the gneiss, but it is only an inconsiderable vein, and probably is not of sufficient importance to be opened.

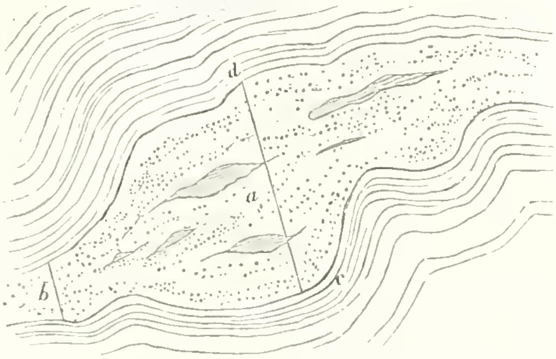
The Hall vein furnishes a remarkably good ore for bar iron; forming a metal that is very tough, and possessed of a moderate degree of hardness. It may be traced for half a mile upon the surface; and should encouragement be held out for the manufacture of iron in this country, this vein will prove one of great importance. It is not so wide as many others, but still it can be raised at a profit, in consequence of its superior qualities. In appearance, and in its associated minerals, it is like the Penfield ore, about ten miles to the southwest in Schroon, a vein which I have already described. It resembles that vein, too, in the quality of the iron which it yields. At one time, I entertained the opinion that the two veins are connected.

Everest's Vein.

Within thirty or forty rods of the Hall vein, is the one under the above name. I am not satisfied whether it is the Hall vein prolonged, or one distinct from it. The qualities of the ore, and the general phenomena, are not very dissimilar. The dip is west, and the width and strike of the vein is about the same in both. The Everest vein exhibits a greater disposition to

absorb oxygen, than that portion known as the Hall vein, and the rock is deeply stained in many places with the peroxide of iron. The walls are very much contorted; and at the opening where the principal ore is raised, the thickness of the vein is rapidly diminishing, which is one of the consequences of this contortion. Figure 64 is intended to illustrate this fact:

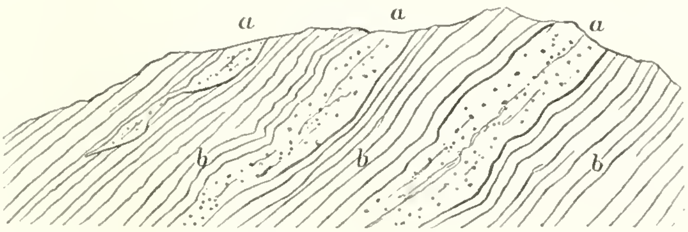
64.



At a, on the line c, d, the vein is eight feet wide; while at b, the place from which the ore is now obtained, it is only four. Although it obstructs the raising of ore, and is therefore an inconvenience and a loss, yet there is no danger that the vein will be lost; the walls may so far approach as to come nearly in contact, yet they will probably recede again, and disclose a vein below five or six feet wide.

In cases where the ore is apparently lost, it will be well to examine the strata a few feet distant; for in some instances, as has been already stated, the overhanging mass of rock may not form the true wall; and if so, the vein will be found, as is suggested, at the right or left. In section No. 65,

65.

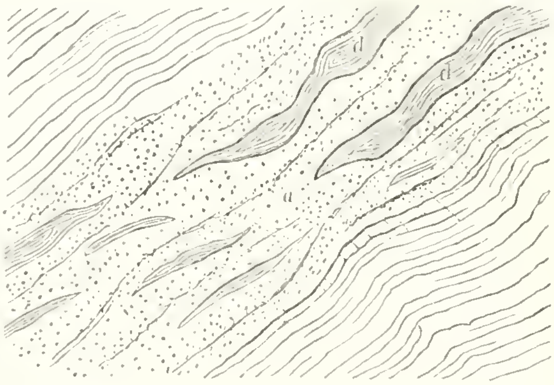


the veins a, a, a, are separated from each other by the intervening masses of rock b, b. In this case, a, a, a, will be found to unite below; and in the progress of mining, the intervening rocks will disappear, and leave a vein twice or thrice the width of either of the former single ones.

Another point worthy of attention, is the arrangement of the particles of ore in the veins: they are disposed somewhat in parallel lines, forming an apparent stratification. Some por-

tions of all the veins are composed of nearly pure ore, lying longitudinally, of the width of several inches; and between these pure lines are lines of grey and white quartz, lying also parallel to the lines of ore. Sometimes portions of the veins are two-thirds quartz, and there are even wider stripes of quartz without any ore at all. I refer for illustration to fig. 66, where *d*, *d*, are parallel masses of rock, quartz or some other earthy substance; while *a*, is the unmixed ore. The narrow lines of rock usually continue as deep as the mine is worked; but the wider parts, which project from the walls or sides of the vein, disappear in the progress of mining.

60.



To prepare the ore from veins of this description, it is necessary to pulverize the whole, and wash the lighter materials away by running water, or separate the iron by the magnetic separating machine.

Very few minerals are mingled with these ores, but some hornblende and feldspar appear occasionally. I did not observe, at either of the openings, any sulphuret of iron, or phosphate of lime or labradorite, substances common at some of the beds of which I have already spoken.

A new vein, or a new opening in one of the same veins, has been made by Col. Everest, which bids fair to furnish an ore still better than any I have yet described. It is upon lot No. 75, Ore-bed tract, and is from three to four feet wide. It is situated some distance east of the preceding, and may be traced fifty rods upon the surface. It is strongly disposed to absorb oxygen, and is very obedient to the magnet, almost the whole of a given sample being taken up by it: it is nearly a pure mass of oxide of iron. In the large way, it is found that two tons of the ore produce one ton of iron. It does not require washing. Its dip and other geological relations are similar to those of the veins already described in this section; and in the purity of its ore, it approaches more nearly to the celebrated Arnold vein in Clinton county, than either of the preceding. It has not been analyzed; and hence it is impossible to determine how much oxygen has been absorbed, or what are the chemical conditions of the ore. It is principally to this fact that chemists should direct their attention in the analysis of ores which work well, and which contain no injurious substance.

The rocks in this part of Moriah and Westport are often quite disturbed, where veins of ore do not appear. The gneiss is schistose, and has a stronger resemblance to mica slate than usual. It is also in many places subject to decompostion, and contains iron pyrites disseminated through it. Hence the outside is often stained brown; it furnishes, very frequently, sulphate of copper; and often its appearance deceives the ignorant, who are led to suppose that it is an iron stone, or one so near an ore, that by digging deep enough, it would certainly be found. In other places the rock contains an abundance of quartz, particularly in the neighborhood of Bald mountain in Westport; and it is often the case, that near the place where this substance is found, lime and serpentine will also occur. Whenever these masses appear, the gneiss is quite as much disturbed or contracted as at any place in the vicinity of the iron veins, and the dip will be as often reversed, as at the locality of primary limestone southwest of the village in Moriah. I cannot, therefore, but regard all the phenomena of disturbance in these instances, whether those attending veins of ore, or those of primary limestone and serpentine, as belonging to and resulting from causes which are radically alike: that they are, in fact, produced by masses which are projected upwards from below. The theory of Mr. Fox, and other electro-chemical philosophers, does not apply so well in the thick heavy veins of iron, as in the thinner veins of other metallic products. But this subject I have spoken of in another place; and while I am unable to apply the theory to the veins of iron, I do not doubt that electro-chemical changes take place in the midst of the rocky strata.

The superficial covering of the beds in this vicinity, appears to be almost entirely of drift. The soil, down to the rock, is filled with round stone or boulders, some of which are quite large. The surface of the rocks, together with the veins where they are exposed, exhibits that kind of scoring which is common where drift has accumulated. The height of the veins above Lake Champlain is from twelve to fourteen hundred feet. The country rises, though not rapidly, throughout the whole distance. The transportation, therefore, of ore to the lake, or of manufactured articles, is not expensive, as there are but few hills to be surmounted, and almost the whole distance is descending to the lake.

It will be seen from the preceding account of the ores of Moriah, (though a part are in Westport,) that this section of country is really rich in ores of iron; that a sufficient amount can be obtained to supply the most extended works; and that most of the localities are favorably situated for a profitable mining. The amount of water power, however, is less than is desirable, being insufficient for large works. The quantity of wood in the neighborhood appears also to be less considerable than might be expected in a country where no large calls for its use can exist, unless for manufacturing purposes. But with a suitable protection of this branch of industry — the manufacturing of iron, one of the most important to this country — I have very little doubt that the ore might be transported to points more favorable for the production of this staple commodity. When it is considered that all the veins lie within five or six miles of the lake, and that for this distance it is one inclined surface, I can hardly doubt but that the ore may be profitably raised and worked when necessary, and transported to places where wood and water power are more abundant. It is true, that this kind of com-

merce must be confined to the best of the ores, which are, of course, as easily raised as the leaner and poorer ones.

Veins of Magnetic Iron Ore in Elizabethtown, Keene and Westport.

I shall not attempt to describe all the veins which are known to exist in these towns, and in most instances I shall be content to mention the places where they have been found.

On lot No. 177, Ore-bed tract, is an extensive vein; it is situated upon an eminence, six miles west from Westport village. This is a new discovery, and opportunity for testing its value has not occurred. Mixed in the proportion of one-third of the ore from the Hall vein in Moriah, it makes a good iron. It has not been analyzed. It is black, and is not disposed to absorb oxygen. The vein is in granite, is forty feet wide, and runs nearly north and south. The ore is rather tough, but is rich, and free from substances which injure the quality of the iron.

On lots No. 140 and 141 in the same tract, are two veins in addition to those already mentioned. I have not, however, given them a particular examination.

Another vein, of an inferior quality, was opened some years since in Westport, about two miles north or towards Split-rock, not far from the lake.

Again, on lot No. 23, Split-rock tract, iron ore occurs. The vein is two feet wide, and runs northeast and southwest. The ore is rather compact and tough, and is associated with hornblende, but it is of little importance.

In Keene, there are also several veins of iron, but none that promise much. At Long pond, on the side of the mountain which has been exposed by the slide already noticed, is a vein, the ore from which was tried at the Elba iron-works, and proved worthless, in consequence of being highly charged with pyrites. The associated rocks give to the mass an interest which it does not possess in itself. Its direction is more westerly than usual; it is traversed by dykes and primitive limestone, and it is contained in hypersthene rock.

Magnetic Ores of Adirondack.

The masses, veins or beds, of which I propose giving some account in this place, are situated in the town of Newcomb, near the head waters of the Hudson river, in the extreme westerly part of the county. They are a few miles west of the centre of the great wilderness of New-York, in which the group of mountains called the *Adirondacks* are situated. They are in fact upon the highest table land of this portion of the State, or upon that platform whereon all the larger lakes are spread.

In giving the following report of these mines to the public, and in particular to the State of New-York, it is my wish to present such views as shall be strictly within the bounds of truth, and in language which shall be generally understood. In the annual reports, I have often brought this subject before the citizens of the State, in the hope that it would be properly appreciated. In the accounts which have been as it were only incidentally given, I confined

myself mostly to the statement of plain facts, giving details of veins and beds, measurements, etc., under the impression that in such a form, every reader would be able to appreciate their value, not only as individual property, but as an interest from which the public at large must derive a great benefit. In this matter, I did suppose that my statements were received as true; and in this belief I should have remained, had it not been for the fact, that a variety of circumstances have, at different times within the last year, called intelligent men into this region, who have been induced to examine the subject of these ores for themselves. The result of all this has been, that these individuals have declared that they were entirely deceived; they had not supposed that such an amount of ore actually existed; they had formed a vague idea that large beds of ore had been discovered, but were wholly unprepared to see it in mountain masses. But that the public, and especially individuals who feel an interest in the subject, may have no cause for saying that the whole truth was not told, I propose to give as full a report as will comport with the main objects of the survey. For, however others may regard the matter, I am fully satisfied that the mines in question are a subject of national interest. My convictions of this fact were strong from my earliest investigations, and they have strengthened with every examination which I have subsequently made.

The iron ores of Adirondack all belong to the magnetic oxide; all are black in the mass, and give the same streak, or the same colored powder. Chemically considered, they are mixtures of the protoxide and peroxide, in the proportion of one atom of the former to two of the latter. They appear less disposed to pass to a state of peroxidation than those in the easterly part of the county, as part of the latter furnish a large proportion of the iron in this high state of oxidation. Now this fact is always an indication of a ready disposition to be reduced; or, in other words, it appears that the state of peroxidation conduces to an easy reduction in the forge. Experience proves conclusively, that when an ore possesses a brilliant lustre, and is not diposed to crumble, but is tough and hard, it does not reduce readily in the forge; and these are the ores, too, which are the farthest removed from a high state of oxidation.

The ores of Adirondack cannot be arranged among the bright metallic ones, and none of them appear to be undergoing chemical changes which might change their lustre, which in general is dull, except in points where a granule is broken. Their texture varies from fine to coarse granular, and they are never more than moderately tough. There are three veins in which we have the principal grades of texture, and each will be noticed in its proper place. As far as examinations have been made, it appears that each mass preserves, as a whole, a uniform texture; that is, if it is coarse upon the surface where it is exposed, we have reason to suppose that such will be its state throughout; and on the contrary, if the upper portion is fine, the mass will continue so. In every vein there will be exceptions; fine-grained masses occur in the midst of coarse-grained veins; and veins which are termed fine-grained, sometimes contain coarse masses.

There is another fact, too, which is important to be stated, and by means of which it may be very easily known what the general nature of an ore is: If, for example, it is what is called a *hard ore* at the surface, there are very slight grounds for believing that it will change into a soft ore as it is explored. It is true, however, that veins are not absolutely uniform

in the quality of the ore which they furnish: different parts of the same vein appear to have different qualities, which often arise from causes not well understood; for example, where a trap dyke cuts through a mass of ore, it always changes the mode of its working, and, I believe, invariably increases the difficulty of its reduction; and when reduced, it makes a a harder iron. The great veins of Adirondack, however, present a high degree of uniformity in the texture of their ores, in their mode of working, and in the quality of the resulting metal, and this uniformity is only equalled by a few of the minor beds in the counties of Essex and Clinton. This I conceive to be a very important fact; for it is perfectly plain that great advantages will always arise from uniformity in these respects, especially the latter.

Again, the ores of all the beds of much consequence have a jointed structure, and break into tabular masses, and in this respect resemble the stratified rocks. This structure is not, however, due to stratification, but probably to crystallization; and it is also probable that this kind of structure is more distinct near the surface, and that as the beds are worked, less of it will appear. This will have some effect in the facility of raising the ore, which will become more compact the deeper the vein is worked, and freer from the seams or divisions necessary to allow the masses of ore to be laid hold of, in order to effect their separation from each other in certain directions.

My examination of the relative position of these veins or beds has never enabled me to determine whether the mass, as a whole, had a dip and line of bearing, or not. It will be seen by an inspection of one of the places, that minor veins occasionally project from the main mass, and pursue a given direction; but where our observations have been directed to a vein as a whole, it has been very often followed by uncertainty whether it pursued, like an ordinary vein, a course which could be denominated its strike or line of bearing. A difficulty which of course contributes mainly to this result, is the uncertainty of distinct walls; and where a mass of rock appears bounding the ore on one side, whether it was truly a wall, or a mass of rock in the midst of the bed or vein; inasmuch, too, as such masses are not unfrequent, and, in the course of mining, run out, and disappear entirely from the vein. From this fact, it will be perceived how it happens that I have expressed myself vaguely in regard to the point whether these masses are truly veins; and as we have no assistance in determining the question from the presence of walls, except in some veins subordinate to a large mass, so we have none in the direction in which the outcrop of the ore appears on the surface; for though they are often situated in imperfect ranges as it regards each other, yet it is not clear that masses so situated are really beds or veins prolonged in such a direction.

In all the uncertainty which lies over this subject, I am more disposed to believe that the whole valley of the Adirondack river is underlaid by the magnetic oxide. It is true that this belief borders on the extravagant, particularly when it is first suggested; but after all, where is the extravagance in supposing that a mountain may be composed of iron ore, or a valley underlaid with it? For aught that appears to the contrary, the interior of the earth may as well be composed of ore, as of rock or stony matter. In confirmation of the opinion expressed above, I shall have occasion to state many facts in the following pages.

With these general remarks upon the ores of Adirondack, I shall proceed to state, with some minuteness, the facts which I have observed in the different places where the magnetic oxide has been explored.

Sanford Ore.

It takes its name from the lake near which the mine is situated. The ore appears upon the west side of a mountain six or seven hundred feet high. Towards the base, the subjacent rock is concealed by a thick stratum of drift, intermixed with many large boulders of hypersthene rock. The mountain rises so gradually from the eastern border of the lake, that loaded teams may be driven to or from the mine with ease. The greatest angular slope is occupied by the ore, but does not probably exceed twenty-five degrees ; and the portion below the mine, towards the lake, has a slope not exceeding five degrees. The distance of the middle portion of the vein, from the lake, is about eighty rods. The ore occupies the western face of the mountain, down which the slope is so equal, that an inclined plane might be constructed from the mine to the lake, for the delivery of ore into boats, in case this measure was deemed expedient. The ore bed is two miles south from the village of McIntyre.

The color of the ore is black ; it is moderately coarse grained, being in this respect intermediate between the fine grained ore east of the village, and the coarse black ore on which the works are located. Structure of the mass, always crystalline, but rarely if ever compact ; lustre, dull ; streak, black ; sufficiently hard to give sparks with steel ; texture, generally rather firm, but never tough, and very frequently friable, constituting what miners call *shot ore*. It never occurs in crystals. The surface masses of the ore are magnetic, but rarely possess polarity. In the mass, the structure is slaty, resembling in this respect a regular rock formation. It is probably owing to crystallization, as it is very difficult to conceive this structure to have been produced by deposition. It is not, therefore, properly speaking, *stratification*, though the lines of separation are parallel like those of veins of slate or gneiss. The existence of this kind of structure favors very materially the quarrying of the ore, and it is even possible to remove large masses with the assistance of an iron bar. The dip of the layers is about seventy-five degrees to the east. Much of the ore, after it is raised, and has been exposed for a time to the air, becomes quite loose in its texture, and its friability is greatly increased.

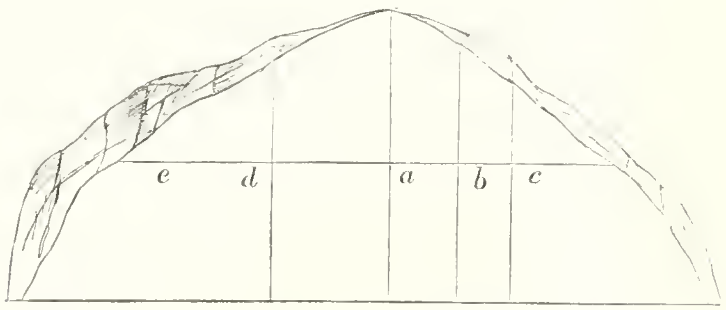
The portions of the vein adjacent to the walls, especially on the western side, are more or less mixed with hypersthene and granular feldspar. The central and eastern portion of the vein, for the space of three hundred feet, is unmixed with stony matter. The layers of rock which appear at the western border probably belong to the surface, and, unless there is an exception to a general rule, will disappear as the mine is worked downwards.

In regard to the dimensions of the vein, it is proper to observe, that it is covered mostly with soil, varying in depth from one to three feet, on which there is a heavy growth of timber. It is not uncommon, however, to see the ore entirely exposed at the surface. To ascertain the whole extent of the vein, as far as was practicable under existing circumstances, excava-

tions, as has already been observed, were made down to the ore, on four transverse lines, and one in the direction of the length of the vein. These excavations were made sufficiently large to admit of a thorough examination, whether of rock or ore; and specimens were taken from each, and labelled and numbered on the spot, to prevent any mistake. By pursuing this course, I obtained the result which will be given in the proper place. As to the actual width, I give only that which was obtained by measuring along the line of excavation, which was made at right angles to the vein; but it is far from being certain that the western limit of the vein was ascertained, as in proceeding west, the accumulation of soil increased rapidly, and the examinations were therefore discontinued in that direction. It is not, therefore, at all certain that I have stated the actual width of the Sanford vein.

By the course described above, the width of the ore on the main line of excavation is 514 feet; and the length, along a line nearly in the centre of the vein, 1,667 feet: it then passes beneath tabular masses of rock. Having given the width and length of that portion which has been actually examined, it is proper to state, that the vein disappears by passing under or beneath the rock at both sides; that it is not discontinued, is proved by excavation at numerous places at the northern and southern extremities, where it may be seen passing beneath tabular masses of the hypersthene rock. The shape of the vein which has been exposed, is nearly triangular. The annexed diagram will explain the nature of the observations which are recorded in the following pages:

67.



a, Middle section; *b* and *c*, two parallel sections south; *d*, section north; *e*, longitudinal section.

Explanation of the Middle Section, and description of the Ore at different points.

I. Middle transverse section, commencing at the western limit, or at the base of the hill, and proceeding nearly eastward, or at right angles to the vein.

First excavation.		No. 1.	Fine granular feldspar, intermixed with iron, garnet and hornblende.
2nd.	36 feet from	No. 1.	A rich ore, breaking into tabular masses.
3rd.	10 feet from	No. 2.	Rich ore, as above.
4th.	15 -- --	No. 3.	A rich ore.
5th.	20 -- --	No. 4.	A rich ore, mixed in a small proportion with granular feldspar.
6th.	12 -- --	No. 5.	Granular feldspar in a decomposing state, containing only a small proportion of ore.
7th.	20 -- --	No. 6.	Rich ore, mixed with a few scales of black mica and feldspar.
8th.	22 -- --	No. 7.	Rich ore, mixed with garnet and feldspar.
9th.	24 -- --	No. 8.	Nearly the same as No. 8, but brighter.
10th.	24 -- --	No. 9.	Rich ore, with a very small proportion of feldspar.
11th.	22 -- --	No. 10.	Loose decomposed rock.
12th.	17 -- --	No. 11.	Rich ore.
13th.	15 -- --	No. 12.	Rich ore, with feldspar.
14th.	39 -- --	No. 13.	A rich granular ore, with a resinous lustre.
15th.	15 -- --	No. 14.	A lean ore.
16th.	22 -- --	No. 15.	Principally rock.
17th.	28 -- --	No. 16.	A pure ore.
18th.	35 -- --	No. 17.	A pure and rich ore.
19th.	36 -- --	No. 18.	A rich ore.
20th.	22 -- --	No. 19.	A pure oxide.
21st.	27 -- --	No. 20.	A pure ore.
22d.	30 -- --	No. 21.	A pure ore.
23d.	29 -- --	No. 22.	A pure ore.
24th.	30 -- --	No. 23.	Ore mixed with garnet.
25th.	14 -- --	No. 24.	Rock mixed with particles of ore.

II. Description of the section 268 feet south of the middle section. Whole width on this transverse line, 610 feet.

No. 1. Good ore, mixed with small particles of decomposed feldspar and hypersthene.
2. Same as No. 1.
3. Same as No. 1.
4. Same as No. 1, but brighter and coarser grained.
5. Good ore and fine grained.
6. Good ore, granular and friable.
7. Good ore, granular, color black.
8. Good ore, with metallic lustre.
9. Good ore.
10. Good ore.

III. Description of the section which is south from the preceding section, 210 feet.

No. 1. Rich, black, coarse grained ore, intermixed with a few particles of decomposed hypersthene.
2. Rich ore, similar to No. 1.
3. Rich ore, similar to No. 1.
4. Rich, black, compact ore.
5. Pure granular ore, coated with a greenish substance.
6. Rich ore, with slight incrustation of peroxide of iron.

IV. Description of the section 231 feet north of the middle or main section.

No. 1. Rock.
2. Rock, intermixed with iron.
3. Fine grained ore.
4. Good ore.
5.
6. Pure ore.
7. Good ore, but intermixed with crystals of hypersthene.
8. Good ore.
9. Rock.

In order to obtain a correct conception of the amount of ore on the Sanford hill, we may estimate its solid contents; or if we merely estimate the amount of ore at the depth of two feet from the surface, we shall find that it amounts to at least 6,832,734 tons, a large proportion of which may be removed or raised without the use of powder. This amount of ore contains at least 3,000,000 tons of iron, of a quality which sells in market for one hundred to one hundred and twenty dollars per ton.

After what has been said of this remarkable vein of the magnetic oxide, little need be added in relation to the advantages it presents for exploration. It will be understood that it is easy of access; that there are no natural obstructions to be overcome in approaching the vein; and that in one sense it lies open and exposed, as it were, to the light of day, as there is nothing to be removed but a light soil, excepting occasionally boulders which have been transported here in former times.

The western edge of the vein is two hundred feet at least above the level of the lake, and it rises rapidly towards the east, so that its eastern limit is probably six hundred feet above the lake. A large proportion of the vein is, therefore, situated above the waters of the lake, and under circumstances as favorable for drainage as can be desired, so that water will form no obstacle to mining or quarrying the ore. Again, in conducting the ore to the lake, or even to the works, the surface of the ground is such that a gradual descent may be obtained. In fact, there can be no occasion for raising the ore over any elevation of ground. So favorable is the location, that after it is raised, it may be rolled downwards in cars or carriages, to the lake for transportation, or to the works directly. Also, the ore being unmixed with rock, no labor need be lost in removing worthless stone; and, as much surface may be at once exposed, all the operations will be conducted in open daylight for a great length of time. In

addition to the advantages which this vein presents for working, I may state that of its fissile character, or its natural separation into layers; hence masses are frequently readily detached by the aid of the bar alone, especially near the surface.

It is obvious that the true method of working this vein, is to commence on a line with the pure ore, or as far down the western slope as possible, and work towards the east, and to the right and left; by this mode of proceeding, all the water which would accumulate above, from rains, etc. will be carried to a lower level than the line of the workings. The whole business of mining, then, at this place, will consist in blasting and breaking the ore, all of which may be conducted without engines of any description. Hence, as it regards expense, there probably never was a vein so favorably situated, and where so little capital will be required to obtain the ore, and transport it to the place where it is to be reduced.

One of the most remarkable facts which I have observed in relation to the Sanford mine, is the entire freedom of this immense vein from pyrites, and also from any substance which is known to exert an injurious effect on iron. This circumstance is probably in part to be attributed to another fact, viz. that the hypersthene rock is one which is far from being metalliferous: scarcely any of the sulphurets or oxides appear in it, except the well known substance, the oxide of iron; whereas, gneiss, the adjacent rock, abounds in sulphurets of iron and many of the earthy minerals, and, as a consequence, many of the veins of iron are more or less charged with sulphuret of iron. The ore of the Sanford vein is one of the purest which is at present known, if we except the Arnold ore in Peru, but which is not a hundredth part so extensive.

As might be expected, the iron made from this ore has proved to be of the first quality; and it is not only of the first quality, but is said to *make fast*. Whether it is of the same quality as that which has been made from the coarse black ore, to be described hereafter, has not been determined. It is sufficient at the present time to say, that so far as trials have been made with it, it is equal to the best of the iron made at the forges in the northern section of the State. Experiment only can determine how good it is possible to make the product from this ore, and whether it has the properties which render it suitable for steel.

The only foreign minerals present in the Sanford vein, are hypersthene, labradorite, hornblende, and common feldspar. In this vein, too, we meet with bottle-green feldspar under its usual crystalline form, but I am not as yet satisfied whether it is prismatic or labrador feldspar. These, though they exert no injurious effect on the iron, yet interfere in its reduction: when they are present, therefore, to some extent, it becomes necessary to wash the ore, and this is the more necessary on account of the low point at which these two minerals fuse.

Northern and Southern Prolongation of the Sanford Vein.

At the distance of about one mile and a half from the Sanford vein, there is an outcrop of ore, possessing the same characters as that just described. If this was the only vein in the country, it would be considered as very remarkable on account of its extent: it is thirty-two rods in length, and about fifteen in width. The mineralogical characters are precisely those

of the Sanford ore, and probably the qualities of the iron will be much the same as those already enumerated.

Another outcrop, apparently of the same ore, occurs on the opposite side of the lake, in the direction of Hill's island. It disappears under the water of the lake, and hence its actual extent cannot be ascertained; that there is a large amount of ore at this locality, there can be no doubt, and sufficient in itself to justify the erection of extensive works. It is not easily determined whether this is really a prolongation of the Sanford vein; it appears a few rods too far to the west to be in the line of its strike, unless the Sanford vein passes beneath the lake, which is not improbable, as the western limit has not been ascertained. The distance of the Sanford vein from the site of the present works, is two miles and fifty-three rods; and the whole surface of the ground is such, that a railway may be constructed which shall have any amount of descent that may be desired.

From these data, then, we may estimate the whole length of the Sanford vein as about two and a half miles. Intermediate between the several large outcrops, ore appears at the surface in sufficient abundance to indicate the presence of the vein beneath. We have, therefore, in addition to the evidence furnished by external characters, that of ore scattered on the surface, on the line of the strike of the main vein; an indication which rarely if ever has failed, when tested by the only sure method, that of excavation. On this subject, I may with propriety remark further by referring to the experience of miners in the vicinity of the Peru iron-works, who have frequently traced a vein of ore, simply by the presence of a few grains in the loose stones on the surface, a distance of a mile at least, and have verified their opinion as regards the presence of ore beneath by excavation. The same fact has also repeatedly fallen under my own observation.

Of the Vein called the Coarse-grained Black Ore.

This vein is situated in close proximity to the site of the present works; in fact, the foundations of several of the buildings rest on this vein. It takes its name from the color and coarse granular texture of the ore. Its texture throughout is coarser than the Sanford ore, and it is harder or more tenacious; still it is not the hard ore of miners, or one that works hard, and produces hard and brittle iron.

As to the purity of the black coarse-grained ore, the same remarks might be repeated which were made on that of the ore of the Sanford vein. The impurities are intermixtures of the earthy minerals, as hypersthene, labradorite, and small masses of dark colored serpentine. In one or two instances, masses of sulphuret of iron, of the size of a butternut, have been seen. That no injurious substance exists in the ore, is fully shown by the quality of the iron produced from it. This is evidence of the best kind, and supersedes the necessity of making any further remarks on this point.

With our present knowledge, it is impossible to assign definite boundaries to this vein. On a line measured east and west, commencing at the supposed eastern limit of the vein, and terminating at excavations near the western limit of the cleared fields on the west, it gives a

width of more than seven hundred feet. By measurement on a line running nearly north and south, or in the direction of its strike, it is found to extend 3,168 feet. The evidence of its vast extent rests on the same data as those which were obtained of the Sanford vein, viz. excavations at numerous points. We did not proceed in a manner so systematic, as in the case just referred to; and in the several examinations made, we found the ore passing more frequently beneath the common rock of the country. To a superficial observer, this great vein might be considered as many large disconnected beds, or beds separated by intervening rock; but in this instance, as in the Sanford hill, we found the ore passing beneath rocks, and not terminating against them; giving thereby strong indications, at least, that the apparently insulated masses of ore are merely parts of a great vein, connected together beneath the layers of rock. Whether this view of the subject is true or false, each of the masses of ore which have been exposed, will furnish any amount which can possibly be desired. The width of that portion of the vein which furnishes ore at the present time for the forge, and has been exposed by the removal of soil, is thirty-six feet, presenting a solid wall of pure ore, unmixed with rock. This is only a single instance among five or six others directly in the village of McIntyre, equally favorable, and in confirmation of the opinion so often expressed, that all the large masses of ore are merely portions of one vast vein. It is, however, a matter of small consequence whether this view is correct or not, so long as such an abundance of ore can be obtained at either of the exposed places, and especially when it is known that either will furnish materials for the manufacture of iron for centuries to come.

Experience has established the fact in relation to the magnetic oxide, that different veins produce iron of different qualities, even when the processes pursued are similar. Another fact, also, is equally proved, that ore from which the stony matter has been separated, produces iron possessed of different properties from that which has been made from the unwashed or unseparated ore.* An instance of the latter kind is furnished in the iron formerly made from this ore. When first used, it was wrought without separation. The iron then made was remarkable for its hardness and toughness or tenacity: it in fact produced steel of the best quality; and the bars which were at that period made, and left in rather a damp place, preserved their smooth appearance, without presenting any disposition to rust or oxidate. This may perhaps be accounted for, by supposing the formation of an alloy of iron and silicium. Whether the explanation is correct or not, the fact is important and interesting, and worthy of being preserved.

Leaving considerations of this kind, I have only to remark, that probably no ore in this country has produced iron of a better quality than the vein now under consideration, or perhaps it would be better to say, is capable of producing better iron. Without entering at all on the statement of facts in proof of this assertion, I shall refer the reader at once to Professor Johnson's report, where he will find a statement of the experiments which were instituted for the trial of this iron. When it is considered that this iron was not manufactured by the most

* This result may be accounted for, on the supposition that a higher temperature is required for reduction under those circumstances.

approved process, but in rather a rough unscientific mode, it seems to be clearly established that there is something very extraordinary in this ore, to produce the kind of iron which is proved by experiment it actually does. And who can doubt, but that in scientific hands, it will prove fully equal to the best Russian and Swedish irons, which have been so long celebrated, and used in the manufacture of steel. Such at any rate I conceive to be the qualities of the iron, that it is a matter of national importance that the operations in its manufacture should be conducted in the best possible mode. There are some particular uses to which this can be applied, and for which there is nothing equal to it made in this country, viz. where there is much wear or friction, and at the same time great tenacity required; as the axles of locomotive engines, railroad cars, or chain cables for ships of war, large spikes, nails, etc. Iron is so much used in the present state of society, and so many lives depend on its quality, that it is a subject of great importance to secure for public use that quality of it which shall not jeopardize life and limb in the public conveyances on the great thoroughfares of the nation. It is in this light that an article becomes important to a nation; and though its patronage benefits, in a pecuniary point of view, the individual proprietors, yet the nation is after all the most benefited by promoting safety and expedition on the ocean and on the land.

Of the Vein called the Fine-grained Ore.

This ore constitutes a distinct variety, and is peculiar in its characters. At the surface, it is always more or less granular; the grains rarely exceeding a common buck shot, and generally much finer. In many parts of the vein, it is quite friable, and belongs to that variety which is termed by the miners, *shot ore.* The greater portion of the vein is quite firm, and requires a smart blow of the hammer to break it. At the place where it has been quarried, it presents a black dull appearance; it has all the characters of rich ore.

The width of the vein is over one hundred and fifty feet; it has been traced continuously in the direction of its length, 5,712 feet; and it preserves a great uniformity of breadth throughout this distance. Its relation to the rock is not as yet well made out.

Generally, at the surface, this vein appears more intermixed with rock than either of the others. I have, however, often found that this is owing in part to weathering; as a large proportion of the particles in mass, though earthy in their appearance, still were obedient to the magnet. Disseminated very sparingly in the ore at some points, are minute particles of sulphuret of iron. My attention was first directed to this mineral by observing a brown stain, and in some instances a thick brown rust over the face of the vein, where it was exposed to the weather: it was beneath the rust, that I detected the mineral. It is not, however, uniformly present; and when it is, it is quite doubtful whether it is in sufficient quantity to affect the quality of the iron. Judging from experience, I am disposed to consider this ore as better adapted to the furnace than the other veins. The presence of sulphuret of iron in part improves the appearance of the castings, renders them smoother, and in fact increases the fusibility of the ore.

Since the above was written, deeper excavations have been made in this mass, and I find that no bed in the vicinity presents a mass of ore so handsome as this.

This vein is situated about eighty rods east of the site of the works, on a steep ridge overlooking the entire clearing in which the village is situated. It extends in a northwest direction, more than half a mile from the works. It possesses all the advantages of the Sanford vein for quarrying. In fact, an inclined plane from the main vein might be so constructed as to carry the ore directly into a furnace. It is, therefore, as favorably located as can be desired, so far as mining operations are concerned, or the transportation of ore to the works.

This ore, though situated in the immediate vicinity of the forge, has not been so largely wrought as the others, and it is therefore impossible to speak so confidently of the quality of the iron which the ore is capable of producing. I have no reason for supposing that it will make bad iron, or that it will work hard. These are points which can be settled only by farther experiments.

Other known veins of less extent in the vicinity of Adirondack.

Of the veins recently discovered, I may mention one on the west side of Lake Henderson, about three quarters of a mile from the works; it is a beautiful fine-grained ore, and is worthy of exploration. Another exists on the west side of Lake Sanford, and nearly opposite to the ore bed; it is quite extensive, but has not received much attention. Another exists on the east side of the Sanford hill; it is supposed to be a continuation of that vein, and an outcrop on that side of the hill; its extent is unknown, but there is little doubt that it is abundant, as it appears in a solid ledge.

Strong indications of ore exist on the East river, and a branch which falls into it from the east. Large masses of a beautiful pure ore are scattered along each of these streams, which have been brought down on masses of ice. Of the existence of one or more beds in that region, there can be no doubt; and as it will be in the vicinity of water power, they may be made to furnish the ore for an establishment on those branches; besides, the whole will be in the vicinity of the railroad which leads to Lake Champlain.

Again, an extensive mass of ore has recently been discovered about three miles southwest of the village, and on the west side of Lake Sanford; it is called the *Cheney ore-bed*, from its discoverer. Though this is a large vein, yet it is of very little consequence, first, on account of being rather distant from the works; and secondly, it does not appear to be an ore so valuable as many others which are more accessible.

In order to exhibit to the reader the true value of the ores of Adirondack, in a form independent of opinion either from mineralogical examination or from ordinary trials made in a rough way, or in one that is more independent of what may occasionally result from accident, I insert a part of a report made by Prof. Johnson, on trials with this iron, made at the request of the present proprietors of this estate. From this report, it will be seen that no doubt remains of the valuable properties of the iron made from these ores.

Extract from a Report, by Prof. W. R. Johnson, *of experiments on the iron manufactured at the village of McIntyre, Essex county, New-York.*

To ascertain the toughness and ductility of this iron, when cold, I caused the bar to be bent at a temperature of 50°, at a part where the breadth was 1·295 inches, and the thickness 0·59 inch. This bend was made flatwise, and continued until the corresponding faces on the inside, about one inch from the middle of the inner curve, were 0·4 of an inch apart, and the widest part of the opening only 0·45 of an inch. The alteration in the form of the bar appeared to be limited to this portion. On measuring along the interior and exterior edges of this curve, the former was found to be 2·15, and the latter 3·8 inches; manifesting a difference in the length of the inner and outer fibres, of 1·65 inches in a length of about $2\frac{1}{4}$, the original extent of the bent portion (see fig. 1). By this trial, the whole form of the cross section of a bar is changed, and instead of straight lines, exhibits only curves. In the present case, the parallelogram fig. 2 was converted into the form of fig. 3, the largest curve being on the inside of the bend.

Fig. 1.

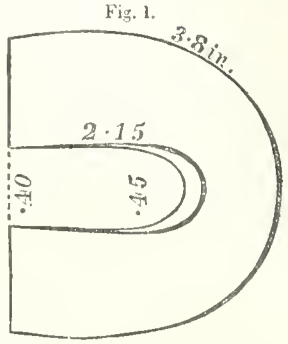


Fig. 2.

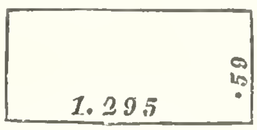
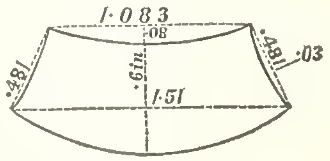


Fig. 3.



This change of figure and displacement of parts were borne without exhibiting any signs of rupture, until the curvature above stated had been attained, when a few cracks began to appear on the exterior part of the curve.

The next test to which this iron was subjected, was to heat a portion of the bar to redness, quench it in cold water, and then bend the same portion cold, in the manner already described. No difference of result was obtained, except a greater facility in producing it. A few slight surface cracks were seen near the close of the operation.

A third trial of a similar kind, on a bar annealed and cooled in dry ashes, resulted like the preceding, but exhibited rather more cracks on the exterior surface of the bend than either of the foregoing.

Another trial of the toughness of this iron, when cold, was made by drawing out a bar 0·7 of an inch wide, 0·18 inch thick, and 5·4 inches long, and twisting it cold in the manner of a common twisted auger, twice round in the length just specified. The edges of the spiral were now exactly seven inches long. Hence, the elongation of the exterior fibres on the edges was $\frac{0{\cdot}7-5{\cdot}4}{5{\cdot}4} = 29{\cdot}6$ per cent. It is proper to state, that this experiment was made

after annealing the bar, and cooling it off in dry ashes. In attempting to carry the torsion beyond this extent, the bar was twisted off at the jaws of the vice, in which the operation was performed.

Having thus proved that this iron is not under any circumstances *cold short*, I caused the bar $1\frac{3}{8}$ inches wide, and 0·6 inch thick, to be heated to a fair working red heat, and in that state bent flatwise over the corner of an anvil, and a right angle exterior and interior to be formed $\frac{3}{4}$ of an inch from the end. The exterior angle remained perfectly sound. On the interior, a thin scale only of metal appeared to be corrugated and partly detached from the rest of the mass, owing, probably, to a defect in welding; but not the least sign of a tendency to fracture was discovered. Another portion of the same bar was heated as before, and three inches of it bent over and hammered flat upon the face of the adjacent part.

Complaints are made by workmen, that much of the iron which they employ will not sustain either of the two preceding operations. They were, however, borne by the iron under trial, without evincing any weakness or undue distortion of parts.

A third test of the quality of this iron, when hot, was afforded by heating about three inches near the end of the bar, and driving a steel punch 0·8 of an inch in diameter, quite through it. This was done without splitting or cracking at the edges, as is too often the case in making screw-nuts. Machinists are well aware of the importance of a good material for the formation of screws and nuts.

The foregoing trials having, as it was conceived, fully established the freedom of this iron from the defects known either as *hot shortness* or *cold shortness*, and its softness and malleability being amply tested by the cutting and hammering incident to these experiments, the next step was to determine the absolute force of cohesion, together with the extensibility, when subjected to longitudinal strain, and the interior structure of the metal under various circumstances, including that of welding in the ordinary way.

For this purpose, five bars were drawn out and prepared from the specimens already described, numbered I., II., III., IV. and V., each about 9 or 10 inches long, 1 inch wide and 0·2 inch thick.

No. I., after being reduced to a nearly uniform size throughout its length, was annealed at a red heat. and allowed to cool slowly in the air.

No. II. was *hammer-hardened*, or beaten with moderate force, throughout its length, until it had been for several minutes black, the hammer being occasionally moistened during the process.

No. III. was forged out and hammered till it was only visibly red in daylight, being left at about the temperature at which workmen cease their operations on many of the articles which they produce.

No. IV., after being brought to an uniform size, was upset for about three inches in the middle, and was then annealed and cooled slowly.

No. V. was drawn out, cut in two in the middle, and welded together: this sample was only $6\frac{1}{2}$ inches long.

All these bars were then carefully gauged, both in breadth and thickness, at every inch of their lengths, before commencing the trials of tenacity. The machine employed in testing them was the same which had been used in experiments made at the request of the Treasury Department, on the strength of materials for steam boilers, for a description of which the reader may be referred to the report on that subject.* The following table will be understood, without any other remark, than that the breaking weights in the fifth column are corrected for friction of the machine. The specific gravities of several of the fragments of each bar, after it had been broken up, are given under the head of observations, and may serve as well to illustrate the general character of the iron in this respect, as to indicate the effect of the several methods of preparation on the density of iron.

The following experiments confirm the evidence already adduced of the great toughness and ductility of this variety of iron. Besides the facts mentioned under the head of *observations* in the seventh column, we may add, that after the first fracture on each bar, a measurement was taken between two of the inch marks still remaining on one of its parts, and the following results obtained, viz :

No. I.	In an original length of	6	inches,	had been elongated	0·87	inches	= 14·5	per cent.
II.	-- -- -- --	4	"	-- -- -- --	0·2	"	= 1·5	"
III.	-- -- -- --	5	"	-- -- -- --	0·6	"	= 12·0	"
IV.	-- -- -- --	4	"	-- -- -- --	0·2	"	= 5·0	"

* See also Journal of the Franklin Institute, Vol. 19, p. 84.

TABLE OF EXPERIMENTS ON THE TENACITY OF THE IRON

No. of the bar.	State of the bar.	No. of the experiment.	Area of section before trial in square inches.	Breaking weight in lbs. avoirdupois.	Strength in lbs. per square inch.	OBSERVATIONS.
I	Completely annealed.	1	0.1890	10175	53820	Length before trial, 10 inches; after, 13·5; total elongation, 35 per cent. Specific gravity after trial, 7·685, 7·676, 7·668; mean, 7·676. After the 4th fracture, the area of section was 0·1064 inch, instead of 0·1986 as at first; diminution 46 per cent. Mean strength of this bar, 53311; greatest difference, 1706 lbs. = 3·2 per cent. of the mean.
		2	0.1929	10288	53336	
		3	0.1954	10345.5	52945	
		4	0.1986	10374	52235	
		5	0.2036	10972.5	53941	
		6	0.2057	11029.5	53614	
II.	Hammer-hardened.	1	0.1980	12967.5	65192	Length before trial, 9·125 inches; after, 11 inches; total elongation, 20·5 per cent. Specific gravity after trial, 7·769, 7·756, 7·779; mean, 7·768. Mean strength, 65713; greatest difference, 2348 lbs. = 3·5 per cent. of the mean.
		2	0.2019	13053	64650	
		3	0.2000	13399.75	66998	
III.	Hammered till nearly black.	1	0.1983	11970	60363	Length before trial, 9·5 inches; after, 12·25; total elongation, 28·94 per cent. Specific gravity, 7·760, 7·778, 7·662; mean, 7·750. After the 2d fracture, the area of section at the point of fracture was 0·1176; diminution, 45·2 per cent. Mean strength, 58912; greatest difference, 2444 lbs. = 4·15 per cent of the mean.
		2	0.2151	12454.5	57919	
		3	0.2163	12768	59029	
		4	0.2213	12910.5	58339	
IV.	Upset in the centre and annealed.	1	0.2086	13110	62847	Length before trial, 9; after, 11·2; total elongation, 24·46 per cent. of original length. Specific gravity after trial, 7·813, 7·731, 7·754, 7·634; mean, 7·733. Mean strength, 63142; greatest difference, 7128 lbs. = 11·2 per cent. of the mean. The last two results belong to the upset portion of the bar; the thickest part of the upsetting remained, however, unbroken.
		2	0.2233	13623	61007	
		3	0.2316	13737	59313	
		4	0.2282	15162	66441	
		5	0.2354	15561	66104	
V.	Welded together near the middle, hammered till nearly black.	1	0.1845	10773	39585	Broke outside of welding. The strength is about the same as in No. III.

To compare this iron with others, it is proper to assume bar No. III. as the standard, that having been hammered till of a dull read heat. The report already cited furnishes us with abundant data derived from experiments, made with the same machine, on other kinds of bar iron, in a similar state. Thus we have,

				Strength in lbs. per sq. inch.
Iron from	Salisbury, Connecticut,	by a mean of ..	40 trials,	58·009
—	Sweden,	do ..	4 "	58·184
—	Centre county, Pennsylvania,	do ..	15 "	58·400
—	Lancaster county, Pennsylvania,	do ..	2 "	58·661
—	McIntyre, Essex county, N. Y. (as above,) .		4 "	58·912
—	England, cable bolt, (E. V.)		5 "	59·105
—	Russia, ...		5 "	76·069

Hence it appears that the last only is essentially superior to the iron of McIntyre. These are among the best varieties of bar iron in point of tenacity.

The fracture is of a light iron-grey color, silky lustre, and generally displays a compact structure. It is worthy of remark, that most of the fractures took place in directions oblique to the line of tension, and making with it, either in the breadth or thickness, one or more angles of about sixty degrees each.

The fibrous structure of the metal was very marked in cutting with the cold chisel, and was further developed by acids on a part of No. III, on the surface of which delicate lines were shown traversing a distance of several inches. The specific gravity in the annealed state was, it appears, increased 1·2 per cent by hammer-hardening.

In conclusion, it may be observed, that as a large and increasing demand for good iron prevails in the United States, in proportion to the increase of finished and accurate machinery requiring superior materials as well as workmanship, there can be no doubt that any quantity which could probably be produced, if possessing the properties of that above described, would command a ready market and the best of prices.

Advantages of Adirondack as a location for the manufacture of Iron.

All the circumstances which are favorable to the successful prosecution of the iron business are centered at Adirondack, except one; and this will be understood at once as referring to its distance from market, without convenient means for transportation. At an earlier day, this would be an obstacle almost insuperable; but at the present time, when enterprises of importance will be prosecuted notwithstanding distance and the interposition of mountain barriers, this single obstacle can not prevent the successful prosecution of this important manufacture.

At Adirondack, I trust it has been clearly shown there is no limit to the amount and quantity of raw material; and that this is of such a quality, as few if any locations in this country can boast of affording. There is, too, a great supply of wood. The valley and mountain sides are

dressed in their primeval robes; the axeman has not shorn them of their pride and beauty; they still wear the livery with which nature first decked them, and in all that profusion too which her bountiful hand ever bestows. These circumstances, taken in connexion with a full supply of water power, render this location one preëminent for an establishment of the largest kind.

But at this distance from market, can the manufacture of iron be successfully prosecuted in the face of competition from abroad, and especially with that of Pennsylvania and other coal-bearing States, where iron and fuel in great abundance are associated, and where its manufacture is comparatively cheap? The answer to this question turns wholly upon that of quality: If the iron produced by means of anthracite would compare in quality with that prepared with wood-coal, the question would be settled against this northern establishment; but inasmuch as charcoal, and that too of a better quality than is furnished by the coal formation, is required for the production of good iron, the discussion of the question turns in favor of the northern mines. The final result will be, that no competition will exist; for while the coal-bearing States will produce one quality of iron, the cheapest and at the least expense, the ores of the north will be employed for the production of another quality, and each will be demanded in all parts of the union. The manufacture of the former will by no means dispense with that of the latter, neither will the latter supply the place of the former. The wants of a civilized community originate an extensive demand for an iron which is hard, and possessed of only a moderate degree of tenacity, and this kind can be made at a much lighter expense than that which is softer and more tenacious; but there are other wants and demands which the former can by no means supply, and for which the purer and finer ores of the north become indispensable. The demand, too, for the latter quality of iron is rapidly increasing: the machinery of locomotives, the axles and other parts where great strength and tenacity are required; and innumerable other calls, growing out of the condition and changes in society, can scarcely be supplied by a vigorous prosecution of this business. Now the Adirondack ores, it is believed, if any exist in this country, are the great source from which our most valuable iron is to be drawn. It is here, if any where, it can be made in this country; and the whole Union, if true to herself, will encourage its manufacture. Mr. Johnson's experiments prove the existence of the qualities herein contended for; but it is to be taken into account, that the process followed in preparing the iron used in his experiments does not impart to it that degree of strength which may be given by a more scientific mode of manufacture. The bloomery process by no means gives an iron of a fibre equal to that furnished by puddling. At least the former method is imperfect: The ore is merely raised to a sufficient heat in charcoal to give up a part of its oxygen, and from imperfect exposure will thus be imperfectly changed or reduced, and give necessarily an imperfectly welded mass of metal, which, when drawn into bars, it is reasonable to suppose, will offer at numerous places an imperfect junction of particles; and the result will be, that in testing, these imperfectly welded places will cohere with less force than others, and furnish an example of a brittle metal. The true state and condition of all iron thus roughly and coarsely made, is, that the bars are not homogeneous; some portions are harder than others, and probably minute particles of unreduced ore are disseminated through the entire metal. When, however, the ores are perfectly reduced

by the more perfect methods of modern times, there can be no doubt of complete success in producing iron of the best quality: not that our northern metal is not already in high repute, but it may be placed in a scale still higher by other and better modes of manufacture.

The above remarks were made, on the supposition that the manufacture would be confined to bar iron. Now, bars, plates and pieces of iron, of an almost unlimited variety of forms and sizes, are required for different purposes, in order to suit the convenience and save the labor of the mechanic, in rough-hammering and giving a general shape to his articles; and therefore public utility would be consulted, and the industry of the producer of iron rewarded in the increased value of his productions, by furnishing the metal in a state already half manufactured to the mechanic's hand, that is, by giving to it the general form required in particular articles.

I have not considered, in these remarks, the high probability the quality of the iron furnishes for its conversion into good steel. This is, however, a matter which experiment alone can set at rest; the question cannot be answered by conjecture; the material must be made; still, the qualities of the iron appear to be adapted to form steel; and as it is only of the best kinds of iron that blister and cast steel are formed, we have reasonable expectations that this iron is adapted to this purpose. In many instances, in the manufacture of the Adirondack iron, bars have been made which would temper or harden, and which, when made into hammers and chisels, etc., were remarkable for their goodness, and the ability with which they stood the severest usage. How far facts of this kind furnish us the means of deciding the question, I will not pretend to determine for others; but since the material is sometimes formed, it requires no stretch of confidence or assurance to believe that, when aided by skill and science, an equally good article may be formed as that which has been sometimes produced by accident.

But another point of view may yet be brought up, which will show the value of the Adirondack ores in a still stronger light. I refer to the method which has been discovered, of reducing the rich ores by means of a small amount of charcoal. The process has two principal steps: First, the deoxidizing of the ore, which is performed by intimately mixing the pulverized ore with fine charcoal, excluding during the process the access of atmospheric air, so as to prevent the reäbsorption of oxygen after it has been once expelled. This process requires exposure to a cherry-red heat for several hours. The combustion of the charcoal goes on as long as the oxide supplies the coal with oxygen; and when that ceases, the combustion of the coal stops. Now it is well known that but a small amount, either in weight or bulk of coal, can be used in this method.

The next step, after deoxidation, is to weld the particles together. These are therefore placed in some convenient form in the furnace, and heated to a white heat, or to that point required for welding the particles together. Now in this last process, the great advantage consists in being able to employ branches of trees, and the smaller kinds of wood; even brush will answer, or any wood sufficiently dry, as hemlock, spruce, cedar, etc. Here is a saving in two ways: first, in the employment of the boughs, or those parts which are useless for making coal, and are generally burnt on the ground for the sole purpose of getting rid of

a nuisance; and secondly, in the kind of wood; and it is believed that soft wood, which makes a poor kind of charcoal, will be equally as good as hard wood for this process.

This method of making iron is adapted only to magnetic oxides, or those which will contain but a small proportion of refuse matter as slag and cinders. It is unquestionably the true process, theoretical as well as practical; requiring less time and less fuel, and giving a much greater certainty and uniformity in the result.

Much has been said of the possibility of employing convicts in the manufacture of iron, and undoubtedly there is some speculation in the matter. If, however, the people ever decide upon making trial of the practicability of thus employing convicts, Adirondack is the only place where the friends of the measure can be satisfied with the trial. It is here only where a sufficient amount of material can be furnished, and where the facilities are equal to the greatness of the measure and of the undertaking. A suitable road is first to be made; and this, without doubt, can be effected by the labor of the convicts. The raising of ore, attending to the pulverizing, washing, etc. preparatory to reduction, will not interfere essentially with any trade; and so great are the water privileges and numerous the mill-sites, that hundreds of hands might be employed in the preparatory steps for reduction. Could the ore be thus prepared upon the spot, numerous establishments might spring up on the upper waters of the Hudson, at all those points which are favorable for the establishment of iron factories; and instead of interfering with those who pursue this business, it will rather aid them; for that part of the business which requires a certain amount of skill and knowledge, may still be in the hands of the manufacturer, while those parts which are mostly mechanical would be performed by convicts.

Trap, Porphyry, or Volcanic Rocks.

The trap rocks of Essex county occupy but a limited territory. The whole county is, however, traversed by dykes, varying in width from half an inch to eighty feet; still, they modify the surface only to an inconsiderable extent. The number is a matter which is worthy of a moment's attention; and when I speak of number, I do not mean to convey the impression that they are by any means all numbered, or have been all seen. It is worthy of notice, too, that at some localities they are quite numerous, while there are other districts in which none have been observed. The veins of magnetic oxide are also traversed by them.

The inquiry of the most interest respecting these rocks, is that relating to their period of eruption; but it is of all others the most obscure, and upon which the least light can be imparted. They are mostly in hypersthene rock, and hence all periods of eruption are entirely veiled in as much uncertainty as the rock itself. The latest of these outbursts of trap occurs in the Hudson river slates, in which I can observe no difference in direction or lithological characters from those which are embraced in the primary rocks. Most of the inquiries under this head are unsatisfactory in some of the most interesting points.

The lithological characters of trap are,

1. Compact greenish masses with a slight granular texture.
2. Greenish masses, fine grained, but with needleform crystals.
3. Trap, greenish grey, with nodules of the same material, which often separate readily from the mass: it is the first step towards a columnar structure.
4. Greenish trap, divided into horizontal columns, but rarely regular in the number of sides; they are triangular generally, and very rarely pentangular, or similar to columns of basalt.

The direction of the dykes is a point worthy of some attention, and there is quite a wide range in this respect. I notice a few, in order to acquaint the reader with their general range, omitting the localities. They are selected from all parts of the county, and pursue the following courses:

4,	N. 60° E.
2,	N. 70 E.
2,	N. 50 E.
2,	N. 40 E.
1,	N. 75 E.
2,	N. 20 E.

I have never observed a dyke which coincided in its direction with the strata, nor one whose direction was due north and south. The nearest to the latter direction is that of N. 20° E., which, however, it is rare to meet with; and the introduction of the single instance in the preceding column alters the average range, and reduces it to N. 50° E., while I am more disposed to receive the average direction as N. 64° E.

One of the localities at which dykes are quite common, is Trembleau point, near Port Kent. This point is the termination of the great range of mountains from the southwest, and the hypersthene rock is exposed upon the shore of Lake Champlain. In the distance of half or three-fourths of a mile, sixteen dykes occur, the average direction of which is about N. 60° E. Some of them are twenty feet wide, but frequently terminate in a number of subordinate branches.

Another point where dykes are numerous, is Port Henry, where several may be observed in the small stream which comes in from the west, and flows over the ledge of limestone above the furnace.

The largest and most important of the volcanic rocks belonging to the class under consideration, are found in the interior of Essex, near the sources of the Hudson river and Ausable. One of these I have described already, namely, the great trap dyke at Avalanche lake, which, in consequence of being the channel of a small stream, has been broken up to the depth of a hundred feet, and the process is still going on.

In this region, in almost every direction, may be observed notches in the ridges, which are most of them produced by dykes, the materials of which have been removed, as at the lake just named.

The general phenomena of dykes are those which accompany mineral veins; hence it is important to observe them: they are in fact, true veins filled with stony matter, and observe the same laws in regard to direction, shifts, faults, etc. as other veins.

Porphyry.

I have already sufficiently described the only porphyry in the Second district. Its porphyritic character is obscure, but still there is no doubt of its true nature. It is a compact reddish feldspar, in which small crystals of the same material are sparsely interspersed. It is columnar, or is disposed to separate in short quadrangular columns, when only slightly weathered.

I have already spoken of the apparently stratified porphyry near Canon's point, in the road and fields adjacent to the point, and now refer to this locality again, as it is one of the most interesting places for examination in Essex county. As this mass of porphyry extends west, it appears to divide into trap-like veins, which are themselves traversed by the ordinary greenstone.

From the foregoing remarks, it will be seen that there are few real outbursts of volcanic matter, except the porphyritic mass just described. This spreads over the surface; while all those rocks termed trap or greenstone are confined to veins of stony matter, which are usually narrow and unimportant. These may have overflowed the channels in which they are now confined, but no such instance has yet been observed.

Trap has been often taken for iron ore, in consequence of being a heavy stone, and often discolored by decomposed sulphuret of iron.

TRANSITION ROCKS OF ESSEX COUNTY.

67.

POTSDAM SANDSTONE.

Having treated in detail of the primary rocks of Essex county, I proceed to speak of the sedimentary deposits. By reference to the map, it will be seen that they occupy merely a narrow belt along the shore of Lake Champlain. The uplift which elevated the great mass of primary, broke off from the main mass of the sedimentary rocks merely their western edge, producing thereby a solution of continuity between those upon the west, and those which lie upon the east side of the lake. These masses spread out and occupy a much greater space upon the Vermont than upon the New-York side; still, the latter are well worthy of a careful examination.

The lowest of this class of rocks is the potsdam sandstone, the southern limit of which is at Ticonderoga, where it occupies a limited area upon the platform above the falls, and below the outlet of Lake George. It occupies the western base of Mount Defiance. It dips to the northwest, and appears again at the village in Ticonderoga. The whole thickness of the rock is about one hundred feet. It is crystalline in the mass, being divided into coarse rhombic prisms. I am unable to speak of its extent northwards; it, however, probably lines the shore of the lake for some distance towards Crownpoint. At the latter place, the primary extends to the lake on the west side, and separates this portion of the sandstone south from that at the north.

The sandstone reäppears two miles north, and is brought up by an uplift bearing the calciferous sandrock: it occupies but a small space, and dipping north, it disappears beneath the calciferous. Adjacent to the base of Bulwagga mountain, it appears again from beneath the tertiary clays and calciferous, forming a belt about one mile wide.

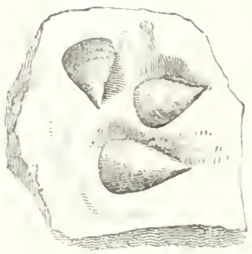
Again, it appears at Cedar point, and lines the shore, with a northerly dip, for about one mile. It is well characterized at this place, but is merely a narrow belt, about one-fourth of a mile wide. It occurs here in a form and condition to be employed for the hearths of furnaces. It extends a few rods north of the furnace at Port Henry, bearing, however, the calciferous. Here it terminates in a rocky point, and appears resting against the primary limestone. The primary again interrupts its progress northwards, but it reäppears under the same characters two miles north, and continues a mile or two, when it is succeeded by the calciferous sandrock and chazy limestone. At Westport, it reäppears again, occupying the banks at the landing, but continues only a few rods northward, when the primary once more reaches the lake shore, and from thence they occupy it to the exclusion of all sedimentary rocks, as far as Split-rock.

The potsdam sandstone does not appear again upon the west side of the lake south of Port Kent. Four miles west of Essex village, it appears, reposing against the hypersthene rock near Ross's bridge. Here I found the lingula peculiar to this rock.

The only locality which now requires a special notice, is at Port Kent, where it appears in considerable force. From Port Kent, it extends west from the lake between six and seven miles, and it is in this vicinity that it presents the greatest interest and importance.

The Ausable river, which, for some distance forms the boundary between Essex and Clinton counties, flows through deep and frightful chasms in this rock. For two miles, at least, this large and rapid river is compelled to flow through a rocky chasm with perpendicular walls of one hundred feet, with a width only varying from twenty to forty feet. A most interesting point for examination is at Birmingham, at the place called the High bridge. At this place, a flight of stairs has been made and placed for the convenient descent to and ascent from the bottom of this gorge. It is one hundred feet deep at this place, and the rocks are rent and broken in the manner represented in the sketch at the commencement of this article, (fig. 67.)

68.



Lingula antiqua.

It is at this place that the *Lingula antiqua* is found in such great abundance, being common in the strata to the depth of about seventy feet. It is, however, extremely obscure. Wherever it exists between the layers, it may be known by the dark colored lines which appear on a transverse fracture. It is extremely thin and delicate, and by far the greatest number appear only in a very imperfect state, and, in consequence, have been frequently overlooked, or taken for a thin film of carbonaceous matter. The medium in which they lived was one which furnished only a small amount of carbonate of lime, a material very essential for the habitations of all testaceous animals. It is the lowest and oldest fossil now known, and the genus to which it belongs has survived all the changes upon the earth from the era of the formation of this rock to the present time.

The surface of most of the layers of the potsdam sandstone appears with ripple marks, particularly at Port Kent, where they are remarkably fine and deep. At the village of Keeseville, the rock is used extensively as a building material; it is, however, the crystallized variety, and hence does not break so readily into those rectangular forms, as the same mass at the Potsdam quarries in St. Lawrence county.

From Keeseville, it extends north several miles, but is very much concealed by beds of sand and gravel, such as may be seen immediately north of the mouth of the Ausable. This place is the most northern point in the State, upon the borders of the lake, at which the potsdam sandstone occurs. Towards Plattsburgh the limestone and shales of the Champlain group succeed, with a dip to the north; and so far as I have observed, or can learn from others, it does not appear between Port Kent and Quebec. Upon the northern slope, near the provincial line in Champlain, and also west of Plattsburgh towards Redford, it forms extensive and important masses, of which I shall have occasion to speak under the head of Clinton county.

From the preceding observations, it will be seen that Keeseville is the most important locality of this rock in Essex county, both as it regards thickness and extent of surface; for I shall soon have occasion to speak of the continuous range of this mass, after passing into Clinton county. In fact, we shall find that it is one connected rock, sweeping around and occupying the northern slope of New-York, along the provincial line, into Franklin and St. Lawrence counties.

I could not ascertain the thickness of this rock at any place which fell under my observation: at the High bridge, it is known to be over one hundred feet from the water below, or from the river to the top of the rocks above, but this is considerably less than the whole thickness. I have often had occasion to notice gorges of this description, at many other places in this district. From present appearances, I am disposed to attribute their formation to a slight fracture, and upheaval of the mass in a given line or direction. Into a fracture thus formed, a river, from some cause or other, happens to fall: the fracture then becomes the natural channel, and, in process of time, the river undermines, breaks up, and sweeps out all loose

materials in its way; or, in other words, forms for itself a channel along the whole line of fracture.

Just above this rocky chasm the river has two fine falls; at the lower one it falls into the chasm, and then flows through it with great rapidity and violence, especially during the seasons of high water; and were not the barriers of the stream composed of the hardest and most durable materials, they would long since have been demolished, at least so far as to give freedom to a turbulent current.

At the village of Keeseville the sandstone is buried deeply beneath sand and gravel, and it only appears where the river has removed these yielding materials. The rock crops out, some distance above the village, in the banks of the river, but it is exposed only imperfectly. In these exposures I found some interesting changes upon the surfaces of some of the layers. One of these presents a smooth and semi-vitreous surface—a kind of glazing. I am at a loss how to explain this appearance, for I have never observed layers whose surfaces resembled this, when composed of sedimentary matter.

Another kind has projections upon the surface; that is, the surface is something more than a mere uneven one; and I can conceive it to have been formed by the dropping or pattering of large drops of water, while the materials were rather soft and yielding, or merely in a semi-indurated state, by which portions of the surface were washed away, leaving the harder parts standing upright. These projections are smooth, and the roughness of the sandstone is thereby somewhat diminished. This surface separates easily from the layer above, leaving in it a mould or cast of itself. If a layer of rock could be heated by applying the necessary agent below, while the upper part was soft, there would be formed, while drying, a surface like this, especially if sufficiently heated to boil.

The last kind of surface which some of the layers present at Keeseville, is checked; a structure evidently produced by the cracking of the layer while drying, the cracks being very similar to those formed in clay exposed to a hot sun. These cracks were subsequently filled by white or greyish siliceous matter, which gives an appearance like that of certain fucoids, particularly the *Dictuolites beckii*, in the Medina sandstone. Under some circumstances, they might be mistaken for this fossil. At this place, too, some carbonaceous matter appears in the rock, though no vegetable or animal forms can be distinguished.

In addition to these diversities in the layers, we find them sometimes deeply stained with iron. In the State Collection, the above varieties are represented in the cases which contain the Potsdam sandstone.

In consequence of this rock presenting two quite distinct varieties, and those varieties being well developed, the one at Potsdam, St. Lawrence county, and the other at Keeseville, I have sometimes given it a compound name—the *Potsdam and Keeseville sandstone;* for the reason that at the former place, a beautiful granular variety exists, and at the latter, a harder and more crystalline mass predominates, which resembles the granular quartz of the Taconic system.

Fucoidal Layers, and Calciferous Sandrock.

In the county of Essex, we do not find circumstances favorable for the full development of all the members of the Transition rocks. From the limited area which they occupy, from their proximity to the Primary rocks, and from their being necessarily but the outskirts of a few lower members of this series, it is not expected that they will present continuous and well characterized masses except in a few localities; and moreover these limited areas will be frequently imperfect, in consequence of the entire absence of some members of the series, their thinning out, or disappearance by denudation.

The mass which has been designated under the term *Fucoidal layers*, is thin wherever it occurs in this district, and it is particularly so in this county. This mass is only distinctly developed at Port Henry; and even here, it is difficult to separate it from the calciferous sandrock; and the same difficulty is not uncommon elsewhere, as the conditions required for making the distinction are not favorable. When slaty layers are interposed between the potsdam and calciferous sandrock, the fucoidal layers appear distinct and well defined; but they also exist where the passage from the lower to the upper rock is effected by a gradual substitution of calcareous for siliceous matter: the fucoids still occupy the intermediate position between the two rocks, but the layers are then thicker; the marine vegetables do not appear so numerous as where argillaceous matter is present, and the mass merely appears worm eaten, or perforated by cylindrical holes, where the fucoids are entirely removed by decomposition, or the surfaces show the remains of vegetables in the condition of external crusts, and without any visible vegetable structure. The usual appearance of the fucoids in these layers is that of a bundle of sticks, both curved and straight, lying, however, in various directions. No appearance of foliage or leaves is visible upon these layers. We find them in all stages: some very distinct and prominent; others obscure, and distinguished with difficulty from ridges and elevations produced by other causes.

The fucoidal layers are rarely more than fifteen feet thick in the second district; and notwithstanding their apparent insignificance, they are remarkably persistent: they are rarely, if ever, absent. Considered as fossils, they are too imperfect generally to be identified by figures, still they are easily recognized when once pointed out. They have, however, sufficient character to show themselves distinct from other marine plants belonging to the same family. On a careful examination of the rocks above, I do not find any traces of them: they therefore appear to be confined to the period of the calciferous sandrock; and should this prove to be a fact, it will give us an additional means for recognizing the position and relations of the strata by the earlier vegetable remains.

I will remark in this place, that vegetable remains seem to be quite as useful in identifying rocks, as those of animals; and as we find them widely distributed upon the same platform, so we should also expect that they would not be as much confined to small vertical limits, as animals: but this is not the fact; their vertical range, if any thing, is less than that of mol-

luscous animals; for while the latter appear to survive long periods, and occur in two or more distinct rocks, fucoids are strictly confined, if not to a few strata, at most to a single distinct rock.

The position of the principal mass, designated *Fucoidal layers*, is between the Potsdam sandstone and the Calciferous sandrock; but to which of these rocks it is to be considered as subordinate, I am unable to determine, neither is it of much consequence. This mass, however, is to be distinguished from layers of fucoids which occur quite uniformly in the calciferous sandrock; for after the latter rock is distinctly formed, I have often found a repetition of the fucoids, but much more limited than the mass below. From this fact, the fucoids appear connected with, or subordinate to the calciferous sandrock.

I proceed now to speak of this mass as it occurs in Essex county. The first appearance of it in the south, and within the limits of the county, is at Crown-Point, about two miles north of the village, on the road leading to the old fortification. It has a northerly dip, and is exhibited in two or three distinct uplifts. It bears the water-lime, or the drab-colored layers which are often employed for hydraulic cement. The whole mass is thin, being only about twenty feet thick.

Proceeding north to Cedar point, the calciferous appears resting upon the fucoidal layers, or it is the upper portion of the sedimentary mass at this place. It is quite limited in extent, and requires no farther notice, except to remark that it is destitute of fossils, and is confined to the lowest layers of the mass.

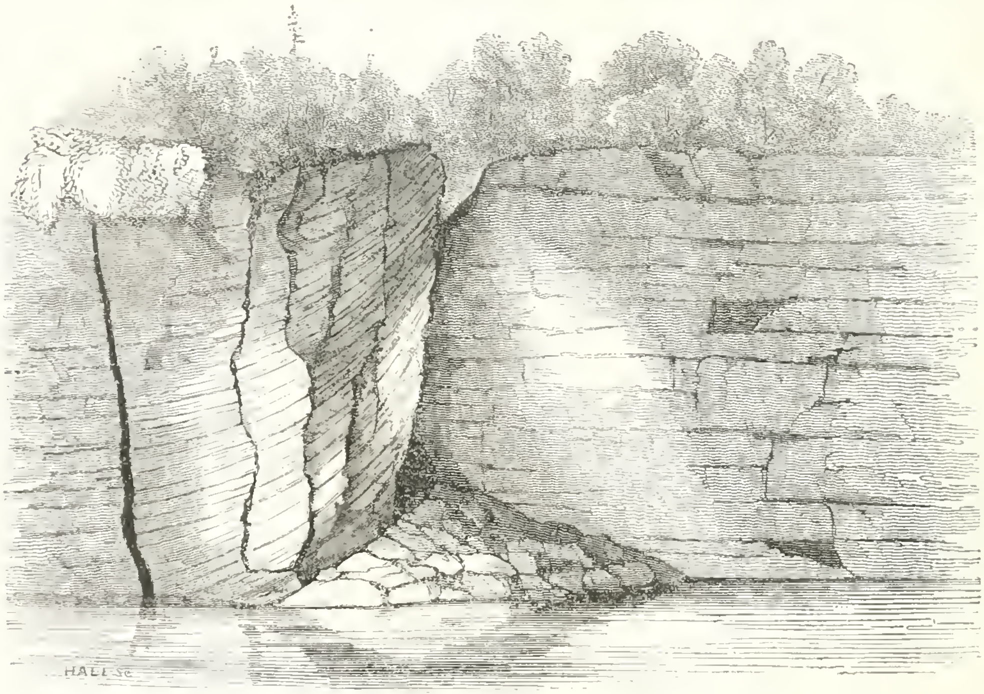
Proceeding still farther north, we find the calciferous two miles and a half south of the village of Westport upon the lake, and it is now in company with the chazy limestone. Near the village, and again half a mile south, the rock appears in beds suitable for flagging, and the various purposes of building. It is of the ordinary variety; and near the village, geodes of crystals are common in the mass. A mile north, the primary, consisting of gneiss and hornblende, forms the north shore of the bay; and for seven or eight miles, these rocks occupy the whole shore in high perpendicular bluffs, as far as Split-rock. This forms the termination of one of the ranges of mountains which has already been described. The shore from Westport to Essex forms the boldest scenery of the lake; and viewed from near Basin harbor on the Vermont line, it forms a scene truly magnificent.

The last appearance of the calciferous in Essex county, is about three or four miles west of Essex village, near Ross's bridge. Probably it continues down to Willsborough falls, where it forms the principal rock at the mills, and is laid bare by the Bouquet, which flows over it. It is geodiferous at this place, and presents the usual characters of this mass. It either passes, at the lower part of the falls, into the potsdam sandstone, or it is the same rock more highly charged with silex. Between the falls and Essex village, it is traversed by a trap dyke, which has altered the adjacent parts several inches upon each side; the alteration consisting in greater compactness and hardness, together with the ability to break with a conchoidal fracture. The action of the dyke is very distinct as well as instructive, showing clearly the state and condition of the mass when it was injected.

In Essex, this rock is of less extent than the sandstone beneath. Comparing it as it appears at Chazy in Clinton county, and at Whitehall in Washington county, it is compara-

tively unimportant. At one locality, however, it forms a good building stone. I refer to some quarries which have been opened within a short distance of Westport. Though it might not polish very perfectly, still it is sufficiently fine for the linings and backings of grates, fire-places, etc. At all places where it occurs in Essex, it passes into the chazy limestone, which it resembles in more respects than one.

69.



View of a fracture and Uplift of the Chazy Limestone at Essex.

Chazy Limestone.

Commencing my description of this rock as it exists in Essex county, and at the most southern point at which it appears, I shall first remark, that I must speak with some doubt of its existence at Crown-Point, unless at the extreme of Long point, as it is usually called, or at the old fortress, celebrated in the early history of this country. In order to speak with certainty on this subject, I should be obliged to make another examination of the spot. The limestone at this place is black, and possesses some of the characters of the calciferous sand-rock, together with one or two fossils which are of a doubtful character: a strophomena occurs here, which has a resemblance to one in the Mohawk valley, in the upper part of the calciferous sandrock. Still I am disposed to consider this dark colored rock as the chazy limestone; and it is highly probable that a thin portion of the trenton may also be found here, the birdseye being wanting.

The upper surface of this rock is plated with a layer of chert, one or two inches thick, which is spread very evenly over almost the whole exposure of the rock on the point. This layer is smoothed and polished by drift, which has been forced over it. The scratches or scorings sweep round to the west, and pass in the direction of Bulwagga bay; the inclined plane up which the boulders were carried being deflected both to the right and left, by the ridge of rock which extended some distance north into the lake.

The dip of the rocks on the point is northwest. As none of them rise more than twenty or thirty feet above the lake, their thickness is not easily determined. Following the shore along the bay, I found a stratum about one foot thick filled with lingulæ: they were confined wholly to this layer; and thousands of them could be obtained, though from the thinness of the shell, it is difficult to obtain them in a perfect state. That part of the rock which has been employed for the fortification, is the trenton limestone. As in the walls, the shaly part of the stone frequently contains the Trinucleus tessellatus and Orthis testudinaria; but the greater part, if not all of this mass, has been raised and put into the walls of the fort.

Proceeding north along the lake shore, the next place at which this rock appears is two miles south of Westport. But not having examined this place with sufficient care to speak confidently of its characters and relations, I proceed to Essex, where, in the neighborhood of the village, it is remarkably well developed, and is especially worthy of a careful examination. The rock, partly within the village, and extending south and west, is principally the chazy limestone. It forms a bold bluff, rising one hundred and fifty to two hundred feet above the lake. Its color is nearly black; it is generally thick-bedded, and without shaly layers; and it is a fine, substantial and durable rock for building. The dip of this mass is west, or a few degrees north of west, or in a direction from the lake; and so far as I have been able to observe, the whole mass is the chazy limestone.

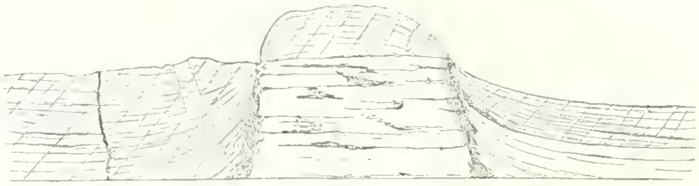
At this place, we first find an abundance of the maclurea, a fossil first named *maclurite* by Lesueur, and which I have changed to *maclurea*. They are large coils, some of which are seven or eight inches in diameter. It truly belongs to the genus Euomphalus.

The immediate vicinity of Essex furnishes an instance in the arrangement of the rock, well calculated to deceive when only a cursory examination is made. Near the central part of the village, where the church stands, we find the trenton limestone very distinctly revealed, bearing its most common fossils, the Orthis testudinaria, Calymene senaria, and several others, in a shaly mass. Proceeding less than forty rods south, we pass on to this dark-colored limestone, elevated at least fifty feet above the trenton; which limestone being of a dark color, and resembling lithologically some varieties of the trenton, might thus be considered, only we frequently find in it the maclurea, which never appears in the trenton. On looking about, however, we shall find, that in going south from the church, we pass a slight depression; and upon a close examination, this will be found to mark the line of separation between the trenton and chazy limestone. This depression is directed towards the northwest, and may be traced some distance: on the right is the trenton, and upon the left the chazy. This depression extends down to the lake shore, and both masses being elevated somewhat above the

water, the contact of the two rocks is seen, when it appears that the former rock has been elevated and pushed through the latter, which was without doubt borne upwards.

But a point of greater interest, though only the same fact is revealed, is a place about forty rods south upon the lake, which may be visited in a skiff, where this uplift of the chazy limestone is still more distinct, being raised forty or fifty feet. On the south, the Hudson river shales are not only bent upwards, but, at a plane along the line of junction, are crushed. The annexed cut is introduced to illustrate what probably took place at the time of the uplift,

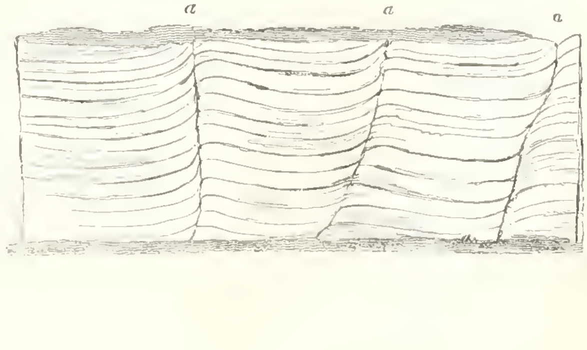
70.



when the whole or entire mass of the trenton and Hudson river shales were uplifted and borne aloft as is represented in the figure.

The illustration at the head of this article (fig. 69), is a plan of the present appearances at the junction of the two rocks; the Hudson river shales upon the south, and the Chazy limestone upon the north. The plane of junction of both rocks is strongly marked, and finely polished by friction and pressure, to which they were subjected at the time of the uplift. Scarcely an instance has been observed in the northern district, which is more illustrative of the mechanical displacement of rocks than at this place; and it is remarkable on account of the limited area to which the uplifting force was applied, for here it extends in width only a few rods, and the fracture is sharp and well defined on both sides, lifting directly upwards a thick mass, breaking through the upper rocks, and leaving them each side in their places, but heaving the lower mass high above, and there suffering it to remain. Almost the whole effect is spent in this uplift upon a space but a few rods in length, but not entirely; for upon the shore north of this mass, we find that an oscillatory movement has been communicated, which has left the rocks as represented in fig. 71. We find the strata broken off at intervals of about

71.

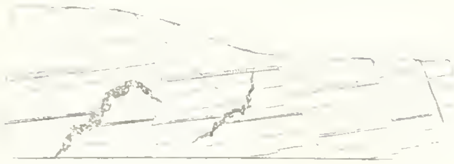


ten feet, and their ends also bent as in the cut. This we may, without doubt, consider as having been produced at the time of the preceding uplift, communicating in this direction a wave-like motion to the rocks.

Near the plane of junction of the southern fracture, there is a trap dyke in the face of the cliff, about two feet wide, which may be traced a mile in a northwest direction. Whether the force required to inject this mass of volcanic matter fractured the rocks as has been described, cannot be determined. I have supposed that the trenton, and the slates and shales of the Hudson river, were borne upwards upon the chazy limestone. We do not, however, find a vestige of either mass remaining, though the chazy limestone may be traced west two or three miles, and we find the other rocks on either hand as has been stated. It is not difficult to reach the cause of this; for there can be no doubt that the whole of that portion of these masses thus elevated has been swept away entirely down to the hard and firm rock called the chazy limestone, at least so as to form a tolerably level surface. This mass is, however, some fifty feet higher than those on either side, though the latter are geologically three or four hundred feet higher than the former. At this locality, then, we have two very distinct kinds of changes, which have taken place since the deposition of the Hudson river shales: first, an elevation of the strata in mass; and secondly, a change by denudation, by which the height of the surface is diminished and reduced nearly to its former level. The scale, it is true, upon which these changes have taken place, is small, and confined really to a limited area; yet it is a fine illustration of the changes which have taken place since the creation of organic beings, and it is the more interesting as the whole effect is within the sphere of our observation.

On the south side of the uplift which has been described, there are phenomena differing somewhat in character from those upon the north, but resembling them in some particulars. Several dykes, in the first place, appear in the face of the cliff, traversing the slate of the Hudson river series. Some of them are in a soft decomposing state, and unlike the one already mentioned in the chazy limestone a few feet farther north; they are both curved or contorted, and apparently insulated or surrounded by the slate. This is probably not the case, but their position may be explained on the supposition, either that a portion of the slate is broken down and washed away, which contained the part which connects whatever now remains in the cliff with the mass below; or else, the connecting part is still contained deeper in the slate, and may yet be exposed as the cliff is broken down. Numerous veins of calcareous spar, too, appear in the cliff in parallel lines. But what is still more interesting, is the shift which the strata have suffered, not, as may appear to some, by the filling of the vertical veins of spar, but probably by the movement communicated to the strata at the time the chazy limestone was thrust through the adjacent mass of slate. The annexed cut will illustrate what has taken place, and the shifts the strata have suffered:

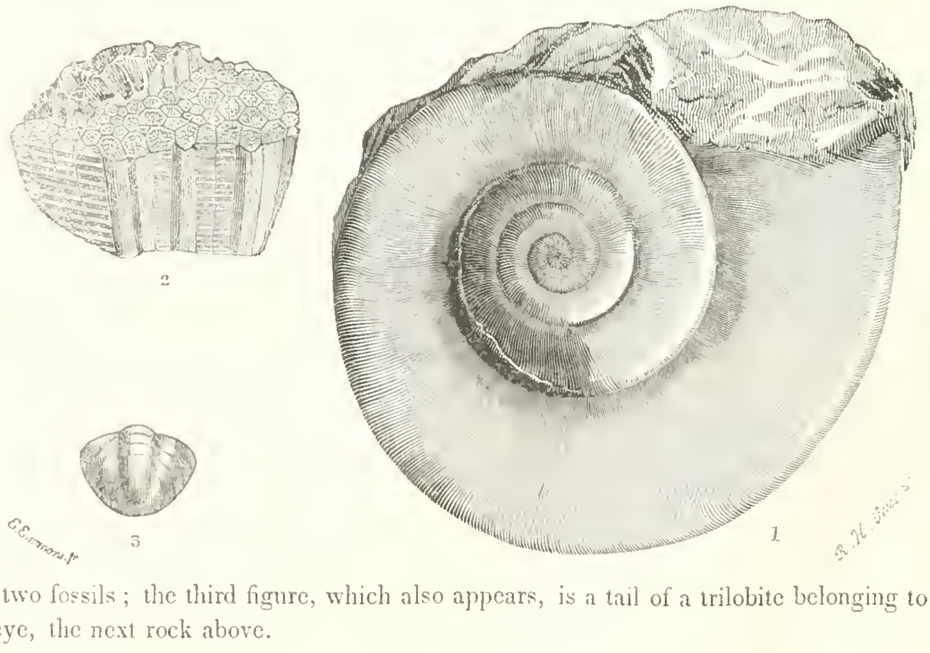
72.



The stratum marked with oblique lines, is one clearly distinguished from the other strata. It is broken, as is seen in the diagram, into short pieces, and these are elevated in succession as they extend south, and at the same time cut off from each other by the veins of calcareous spar, some of which are parallel with each other. All the strata have suffered the same movement from top to bottom, but the one marked with oblique lines is a stratum of limestone, which is readily distinguished from the slaty ones, and hence becomes easy of reference. The dark short thick lines are the dykes referred to above; some portions of them are like putty, or paste, and are constantly washing out. Coal seams are dislocated in a mode precisely analogous to the stratum of limestone in this cliff, often occasioning great perplexity to the miner.

There are two fossils which appear to be characteristic of the chazy limestone. The maclurea already referred to, and a columnaria much resembling the Columnaria sulcata. A large species of orthoceratite also is quite common at Essex. The annexed drawings of the maclurea (No. 1), and columnaria (No. 2), will convey to the reader the characteristics of

73.



these two fossils; the third figure, which also appears, is a tail of a trilobite belonging to the birdseye, the next rock above.

In the maclurea, the coursing of the lines, which are used in the shading of the figure, run in the direction of the lines of the shell; but almost the whole of the shell is naked, or in other words, it is an inside cast, only a portion of the shell remaining near the mouth. So far as any markings of the cast upon the outside appear, they do not indicate the existence of septa or divisions similar to the nautilus; nor have I yet succeeded in finding a specimen which exhibited any traces of a siphunculus. This interesting fossil is credited to Basin harbor in Vermont, opposite Westport, and also to Eighteen-mile creek; but the latter reference is undoubtedly a mistake, as this species is confined to the limestones below the trenton, while the shales of Eighteen-mile creek belong to the Erie group.

Equally limited is this species of columnaria: thus I have noticed it at Essex, Chazy, Isle La Motte, Glen's-Falls and Watertown; and at each of those places it occupies the position I have given it, never appearing in the upper layers of the calciferous sandrock, nor in the lower layers of the trenton limestone. I am not able to say that neither the maclurea nor columnaria ever occur in the birdseye limestone. Traces of a coiled shell similar to it appear in a mass which resembles the birdseye at Chazy, but it is the only locality in the Second district at which I find any traces of this fossil.

This rock is about one hundred and thirty feet thick in the valley of Champlain. It does not appear to be a constant mass, and I am disposed to believe that it does not exist in the Mohawk valley, nor upon the Black river, where the other limestones of the Champlain group are so well developed.

Trenton Limestone.

This rock succeeds the chazy limestone in Essex county, the birdseye appearing to be absent. Upon this point, however, I do not speak positively: it may exist, as it does in one or two instances in the Mohawk valley, in a very thin stratum, perhaps less than a foot in thickness; or if in thicker masses, very imperfectly developed, and with its specific characters indistinctly revealed.

The trenton limestone, though not in its usual force and thickness, yet is very well formed and tolerably well characterized. At Essex village, as I have already had occasion to say, it forms a mass forty or fifty feet thick, and is, as usual, a shaly rock, and filled with fossils, particularly the Calymene senaria, in imperfect specimens by hundreds. A large species of orthoceratite is also quite abundant, some of which are two feet long, but it is difficult to obtain an entire individual.

A locality two miles south of the village, is more important. The rock does not appear on the roadside, but may be observed about half a mile west of Whallon's bay, in the meadows upon a small stream which flows into the bay. The rock dips to the east, and is composed of slaty layers alternating with those of a shaly limestone, in which fossils are numerous, particularly the Puffball favosite, several species of corallines, the Trinucleus tessellatus or Tessellated trilobite, Calymene senaria, Orthis testudinaria, etc. It is not exposed, however, to a great depth; forty or fifty feet is all that can be seen. It is certainly the trenton limestone, and is very clearly revealed by its fossils and lithological characters.

From the preceding remarks, it will be understood that this rock has less thickness in this county than usual, but still it is to be regarded as a mass very well characterized. In pursuing the geology, however, of this valley, this rock is an important member in this series, and it is sufficiently well brought out to preserve the order and relations of the masses in this particular field.

Utica Slate.

This rock being only partially exposed, and occupying only some of the most depressed portions of the county, cannot be so fully described as some of the lower rocks of the Champlain group. It appears first near Split-rock, occupying the southern side of Whallon's bay. At this place it lies against or upon the primary, in consequence of its extension in a particular direction; or it appears here, as along some other extended lines, to overlap the rocks beneath, and to rest visibly upon the primary; that portion only which extends beyond the masses beneath it, being in contact with the oldest or Primary system.

This mass at Split-rock is worthy of examination, in consequence of the curvatures in the strata at the line of junction; from which it appears, that since the consolidation of the slate, this portion of the Primary system has been elevated at least in part.

Proceeding along the shore, we find the remains of a porphyry dyke in imperfect columns in the slate. No change in the texture or structure of the slate appears. The Triarthus, and numerous specimens of Graptolites which are found within one or two inches of the porphyry, appear as in the same mass when remote from a plutonic rock. Neither are the layers disturbed or contorted, in the vicinity of this injected rock.

We may trace the utica slate on the shore as far as the uplift of the chazy limestone, a distance of a mile. After leaving this mass, which contains the porphyry, we soon find it disturbed. It now dips on this shore in all directions, and its layers are more or less bent. When it comes in contact with the chazy limestone, as has been described, it is injected with numerous trap dykes, and traversed by veins of calcareous spar.

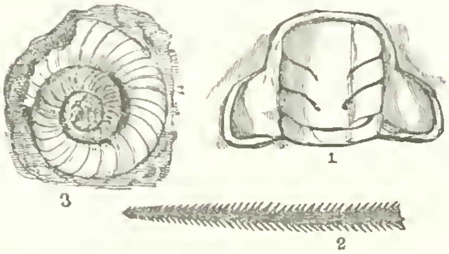
After this interruption by the disturbances at this place, the utica slate does not appear until about half a mile north of Essex. It there occupies the whole shore as far as Peru bay. It forms only low banks, and here is barely exposed, so that we see merely the upper surface. Two miles north, it is more exposed near the road than along the shore, by a small stream which has cut a channel through it for seventy or eighty rods. At this place, it is again traversed by several dykes, one of which is a porphyry resembling that near Split-rock, and at Canon's point.

After searching a long time for fossils in this mass, I was unable to find any; though from its being disturbed, the unsuccessful search does not prove their absence.

This rock is the highest in the series in this county, and it is confined to Essex and the lake shore for a few miles north. In it we find no important mineral substances, and inasmuch as it is brittle and subject to decomposition, it is never suitable for roofing. After drying, and then being moistened, it is liable to crack and fall to pieces; and by a want of cohesion, it is generally channelled out by small streams which flow over it.

The Triarthus beckii is one of the most common fossils of this rock, a figure of which is annexed (No. 1), together with Trocholites ammonius (No. 3), and Graptolites dentatus (No. 2). Individuals of the first named species do not, however, often appear crowded together,

74.



but generally only two or three individuals are found near each other. and neither does every locality furnish specimens of it.

This mass never abounds in fossils of any kind: they are more numerous near its junction with the Loraine shales; and it is possible, that inasmuch as this is more exposed to denuding agents, this portion may be very frequently removed. Near the trenton limestone, fossils are very scarce; but proceeding upwards they increase, and in some localities, as in theLorain e gorges, they become quite common near the shales which succeed.

New-York System in Vermont.

Before leaving the rocks of Essex county, I deem it necessary to notice their appearance on the east side of Lake Champlain. This sheet of water occupies a space intervening between the broken edges of the several masses which line the shore upon each side, and it seems to have been made partly by a fracture through them, extending nearly due north its whole length. The dip of the rocks favors this hypothesis, for they are thrown in many instances each way, or from the lake: the rocks upon the west side, dip very frequently west, or northwest; and those on the opposite side, to the east. These rocks occupy by far a much greater area upon the east than upon the west side, with the exception, perhaps, of the potsdam sandstone, which appears in great force only on this side at the head of the lake, where it forms a mountain at Whitehall; but it is particularly found extending for several miles down the lake, in high mural precipices. It does not appear below Kenyon's landing, a distance of about twelve miles from the head of the lake.

Opposite the county of Essex, a very perfect series of the Champlain group is exposed at different points. But the most useful and interesting places for examination are those which are opposite Port Henry and the village of Essex; the first is Addison, and the second, Charlotte.

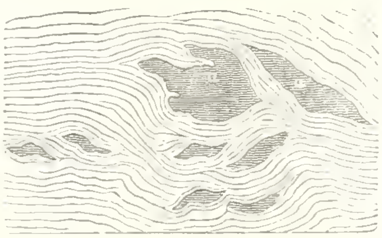
The rock upon the lake shore in the former place, is the trenton limestone. Seven miles to the east, Snake mountain rises boldly from the midst of a plain. At the base of this moun-

tain, the rock is the same as upon the shore. The mountain, however, which is probably eight hundred feet high, is composed of the members of the Champlain group, with the exception of the potsdam sandstone. It appears to have been raised directly up, and is very steep upon the west side, and upon which the following rocks are exposed, beginning with the lowest, namely, Calciferous sandrock, Chazy and Trenton limestones, Utica slate, shales of the Hudson river, thick-bedded grey and reddish sandstone, terminating in a grey limestone. The last named rocks form a perpendicular mass from eighty to one hundred feet, almost inaccessible on the west side.

It is unnecessary to describe in detail the rocks of this group again: it will be sufficient to remark that they present much the same characters as at the localities already noticed; but being compressed into a small space, we have a better chance to inspect the whole group, and hence an opportunity is given for adding a few facts to those already known.

Of the rocks which compose the great part of Snake mountain, the upper ones present some characters which are unknown in Essex; and, in fact, two of the members do not appear upon the west side of the lake, or in this county. The middle part of this mountain is occupied by the shales and slates of the Hudson river series, and they probably will be found four hundred feet thick. The upper part, or that which is exposed under these high perpendicular cliffs, is a mass of shining argillite, with some siliceous matter, traversed by irregular seams of calcareous spar, the laminæ of which are quite contorted and irregularly bedded. Some of the layers near the junction of the grey sandstone, or grit-rock, are composed of a soft green slaty matter. The whole of the slaty mass exposed along the base of the cliff, is without fossils. We find much the same appearance at the junction here, as at other places: an alternation for a few feet of the two rocks, as the commencement of the one which is to succeed, and then the reäppearance of the mass beneath; and frequently large irregular beds, or portions of strata may be observed, as in the following cut (fig. 75), where *a*, *a*, are masses

75.



of grit lying in the midst of the slate, insulated apparently from the mass above; and thus we find, for miles, the same general phenomena. The irregular alternations continue for ten or fifteen feet, when the thick-bedded sandstone or grit appears without interruptions of this kind. This mass of grit is the *greywacke* of authors. Some portions are brecciated, or belong to that variety denominated *rubble*, by the late Prof. Eaton. The predominant color of the grit is grey, but it is sometimes reddish brown.

The grit-rock of Snake mountain is equivalent to the grey sandstone above the Loraine shales; the latter of which, the reader is to bear in mind, is simply a synonime of the Hudson river shales, both terms being occasionally used to designate the same rock: they differ, as has been already pointed out, only in the physical changes which each has sustained. At Loraine, they are but slightly removed from a horizontal position; while along the Hudson river, they have been fractured and elevated in a high angle, or a steep dip to the east has been given them.

The fracture here spoken of, is one of the most interesting and remarkable of all the geological phenomena which have been disclosed during the New-York survey. At Snake mountain, it is particularly worthy of notice. As has been stated, from the lake to its base, it is seven miles; the whole distance is level, and the tertiary is the only formation which appears, but we know it rests upon the shaly part of the trenton limestone. The rock then continues to the great fracture at the base of the mountain; and we find, when we commence the first ascent, that we have left the rock just named, and have passed from that to the calciferous sandrock. We leave the trenton slate at the base of the mountain. After passing over the calciferous sandrock, we soon find ourselves upon the chazy, then upon the trenton limestone, utica slate, and Hudson river shales, each in its order, as we ascend the mountain, till finally we reach the base of the cliff composed of a hard grit rock, the upper part of which is a grey limestone. Sometimes this mass is calcareous throughout its whole extent, effervescing strongly with acids; and then again it is very deficient in lime, the whole mass being mostly siliceous. I know of no rock, especially if we take in the grey even-bedded sandstone just cited, so given to change; it is sometimes a rubble, sometimes brecciated, and again calcareous in various degrees. It is often green, reddish or brown, and frequently the upper part is a pure white limestone.

The fracture at the base of this mountain may be traced a great distance north, appearing, however, more distinct where the uplifts are the greatest. The direction and bearing of this fracture being once known, it is easily traced; but in order to state the facts revealed, and to enter upon details in relation to it, more investigation is required than I have been able to give it.

I shall now proceed and speak of the rocks at Charlotte, opposite the village and township of Essex. At this place, their order and position is much the same as at Addison. The shore upon the Charlotte side is formed of the trenton limestone: it continues half a mile, with an easterly dip; when it thins out, and we pass to the chazy limestone, with a dip to the west. The rocks are, however, much concealed, until we ascend the hill upon which most of the village stands. Near the church, there is a fine outcrop of the grit-rock which has been described. It is here in regular beds, and they are strictly a sandstone, the particles of which are angular, but not coarse. At Charlotte, the rock is reddish brown, and the whole mass is siliceous, the grey limestone being wanting. As a whole, it has quite a strong resemblance to the old red-sandstone. There is, however, one particular in which the sandstone differs in all its phases from other siliceous rocks: the particles of quartz are hyaline, or have a translucency which we do not discover in other sandstones; and the mass, though red, is

more like a stain than a fixed and incorporated color, penetrating and filling up all the interstices.

The glazed slate, beneath the sandstone, is not so clearly exposed as at Snake mountain, yet it may be observed between the two eminences near the summit of the hill. The fracture and uplift are equally distinct, but the elevation is not so great, neither was the force so concentrated as in the former instance: part of the effect seemed to have been spent in the disturbance of the limestones at the base of the hill, bringing up and disrupting the chazy limestone, and giving it a westerly dip. The phenomena in general are the same here as at Addison, excepting that the rock is thinner bedded, and more regular in the planes of deposition.

The sandstone at Charlotte is destitute of fossils: not even a vestige of one has ever been discovered along the whole range from Columbia county to the Canada line; and still it appears to be a mass equivalent to the grey sandstone immediately below the Medina sandstone, which, occasionally at least, contains fossils, though it must be confessed they are much less common than in the shaly sandstones of Loraine.

The materials of this rock appear to have been derived from the slates of the Taconic system, which succeed on the east. The position of these rocks favors this view; and besides, when we examine the quartz in this sandstone, we find it possessing the same characters, particularly in its translucency. In addition to this, it has often the green chloritic coloring matter of those slates, which is very distinct too in the coarser or brecciated varieties.

One important and interesting question arises, when we have completed our examination of the masses which are exposed by the fractures and in the uplifts above described: Is the whole and entire thickness of the Hudson river shales exposed? Without answering directly in the affirmative, I would say, that in and among these shales, I have not discovered masses possessing other characters, or so materially distinct as to throw them out of the group. In other words, I would say, that the different parts of the mass exposed in these uplifts represent the whole mass of the Hudson river shales. Where they are undisturbed, their thickness in the Second Geological District never exceeds five hundred feet. In this disturbed range east of the Hudson river and Lake Champlain, I find about the same thickness. In proof of this, I cite the thickness of the whole mass at Snake mountain and at Charlotte, where, from the calciferous upward to the grey and reddish grits or sandstone, we pass over the trenton, utica slate, and a mass of shales whose characters are those of the Hudson river; and as we find the same rocks here with about the same aggregate thickness that we find them in the undisturbed district in Jefferson county, I believe we may conclude that the affirmative of the question proposed above is in part at least sustained.

TERTIARY OF ESSEX COUNTY.

After having given a very full description of the tertiary of the northern district, it will be needless to occupy time and space with repetitions of what has already been stated of this deposition. I shall therefore only observe, that all the argillaceous depositions, excepting those more than four hundred feet above Lake Champlain, belong to this formation. We find it spreading out and occupying most of the surface adjacent to the lake, where the primary rocks do not come down boldly, or terminate in high cliffs. It possesses the ordinary characters of clay, but is more calcareous than the plastic clays of Amboy. It differs in another particular from some of the tertiary clays of an earlier period, as it never contains sulphuret of iron, either in nodules or in fine disseminated particles. The foreign substances, either mineral or vegetable, which I have observed in it, are extremely limited, as will be seen by the following statement: Lignite has been found in one instance; the locality at which it may probably now be seen, is in a meadow belonging to Mr. Whallon of Essex. It is in small pieces, being merely some of the common kinds of wood which have become carbonized by the usual agents. From some portions of this tertiary, springs issue, highly charged with epsom salts: the shore between the old fortress on Long point and Crown-Point village, furnishes several. In a dry time, large surfaces of the clay are covered with a bitter saline efflorescence. Wells dug in this clay are invariably filled with hard water; and if they are situated in those beds which throw out a saline efflorescence, they are wholly useless, and are not even fit to supply cattle with water, unless they happen to be filled with rain water. They may sometimes be used as reservoirs, the contents of which will serve for ordinary purposes, when well supplied with rain water. Clay stones, or small septaria, abound in many places: they are of every variety of form; and I may here remark, that wherever calcareous matter is mixed with argillaceous, the former invariably separates, and forms these singular bodies. Wherever they exist, it is an indication that the clay is unsuitable for bricks, inasmuch as it contains too much lime, which, after the bricks are burned, will slake, and destroy their texture.

Two genera of molluscous animals are found throughout the entire length of Lake Champlain; they are, the Saxicava rugosa and Tellina grœnlandica. The place most favorable for observing this formation, is Port Kent. Several shells occur here, which are not to be obtained at any other place upon the lake; such as the Mytilus edulis (which has been referred to under the name of Modiola), Balanus, and one or two others: the former is the most common and perfect of the fossils at this locality. At this place, too, the whole formation exists — all the clays and sands, with the intermediate varieties.

This lower mass of the clays forms a good brick; and the upper, which appears to be more calcareous, may undoubtedly be employed to give greater consistence to the sandy soils in the vicinity. The sands of these beds are rarely sufficiently free from feldspar, augite, iron, etc., to be employed for glass, and they answer merely for the ordinary kinds of mortar.

Though this formation has been stated in general terms as occurring the whole length of

the lake, yet it will be found in insulated beds or masses, and in this respect it resembles the rocks. It extends from the lake in the rear of all those low ranges of mountains which have been described as terminating upon its shores; but on leaving the lake, it rarely contains fossils, though it preserves its lithological characters.

The fact now stated, that the fossils are confined to the present shore of the lake, goes to favor the opinion often expressed in this report, that the topographical features of this portion of the State have undergone no important changes since the deposition of the tertiary. The estuary was undoubtedly deeper than the lake; but the most favorable positions for those animals whose remains are now found, were near the present shores of the lake; and to restore in our minds the former conditions, we have only to imagine the valley slightly depressed, to sink the shores to that depth at which the same species are now found in our present estuaries and coasts.

Superficial Deposits, Drift, Peat, &c.

In a region so mountainous as Essex county, it cannot be expected that extended deposits of any of the later kinds should exist. There are no wide plains and valleys for their reception: hence we merely find a few unimportant beds of peat, bog iron ore, marl or tufa. Drift, one of the most superficial of all the deposits of this county, exists every where, except upon the sides and summits of the highest mountains. The general arrangement also prevails here as elsewhere, and the same general phenomena. The loose materials were all transported southward, and hence the boulders of hypersthene rock do not occur on the east or Vermont side of Lake Champlain. The fragments of the porphyry dyke at Essex are found at the south, but never to the north of Canon's point; and the peculiar reddish greywacke or grit is common for a great distance south, but it never reaches the higher valleys of the Hudson river.

At the base of the ranges of mountains, I find an accumulation of debris composed entirely of the hypersthene rock; and being unmixed with other materials from other sources, I am disposed not to regard it as the ordinary drift of the country. It appears to belong to a different period, and to have been deposited by different agents. If, however, it is to be regarded as ordinary drift, it has been transported only from the sides and summits of the ranges to their bases, and it appears rather to have slidden down to its present level. The facts are more clear in consequence of the peculiar location of the northern ranges, and their abrupt termination, and still more so from the well known characters of the rocks themselves, their debris being as easily recognized as the parent rock from which it is derived. Without stating specifically the position of this debris, I only remark generally that it may be observed in the vicinity of most of the head waters of the principal rivers which rise in this region. It is, of course, local: no continuous beds or extended lines of these materials are ever seen. It may be distinguished from drift, by the more angular shape of the masses: the stones in these beds, though somewhat rounded, yet are much less so than in drift, or where the same materials are accumulated.

The above remarks apply to the sand and gravel beds situated in the upper valleys of the Adirondack mountains, upon their less sloping sides, or where the inclination is only moderately steep. I find, however, in some of the deep depressions, where there are natural meadows, beds of clay, analogous to the porcelain clay from the ordinary varieties of granite. The hypersthene rock, like that of the granite of Johnsburgh, disintegrates, and finally decomposes; the alkali leaving the alumine and silex of the feldspar, a complete separation of the elements ensues. The clay which results from this decomposition, collects slowly in those depressions which are favorably situated. These beds are found in the midst of the Adirondack mountains, where they are from eighteen hundred to two thousand feet above the level of Lake Champlain. No analysis has yet been made of this variety of clay, but probably the proportions of silex and alumine will not differ very materially from those of the common porcelain clays. From this clay an excellent brick has been made, which possesses very refractory powers: it at least has one property which is quite important, viz. that of remaining sound when dried in the sun or fire, and it may be heated suddenly without breaking or flying to pieces. The color is light blue, or bluish white; but I have never observed it a pure white, neither does it become white by burning: the bricks are yellowish after burning. It is not so tenacious as the tertiary upon the lake, and does not adhere so obstinately to substances put into it; still it is ductile, and moulds well. I am inclined to believe that this clay is adapted to a variety of purposes; but as it has only been employed for brick, my belief is only a matter of opinion. Its fineness, and ability to stand high degrees of heat without melting, but more than all its freedom from cracks when dried or burnt, impart a value to it above all ordinary clays. In the use of it for fire-brick, however, it is necessary that it should be employed with a pure siliceous sand. The sands and gravel in the immediate neighborhood being made up of a great amount of feldspar, operate as a flux to the clay, and will cause it to melt. It will be much better to employ it without sand, unless it be one composed purely of silex.

Simple Minerals.

The names of many of the simple substances have already been given; a brief repetition, however, is necessary in order to exhibit the mineral riches of this county in their true light. Those which occur in the condition of rocks, may be put first:

1. *Labradorite.* This substance has not yet fallen under my notice under any form except the primary, and under cleavage planes. In this respect, it is analogous to the feldspar which forms the constituent of ordinary granite.
2. *Calcareous spar*, or *Carbonate of lime.* Very few localities where it is crystallized. One of the most interesting varieties is the blue of Long pond.
3. *Magnetic oxide of iron.* The same remark is called for in regard to its crystallization, as in the preceding substances. It is uncrystallized, except in the mass. Not a single crystal has fallen under my notice during the survey, though I have examined very carefully all the mines in the county.

4. *Quartz.* Good specimens of crystals are unknown; small ones occur at Crown-Point, and tolerable good masses of rose quartz half a mile north of Port Henry.
5. *Pyroxene.* It is found at numerous places, and under a variety of forms. The most perfect crystals, as well as best of the coccolites, are to be obtained at Long pond.
6. *Hornblende.* The localities of common varieties are numerous, and tolerably good. Actinolite has been procured from near the beds of primary limestone.
7. *Serpentine,* usually associated with carbonate of lime. Beautiful serpentine exists at Port Henry, with seams of fine asbestus, and a radiated mineral similar to talc; but its nature has not been determined.
8. *Scapolite.* It occurs in large crystals at Long pond, and in small ones in Schroon; they are often coated with a thin brown film, which has some resemblance to brown tourmaline. It occurs at Keene, under one of its secondary forms: crystals, long and striated, terminated by a four-sided pyramid.
9. *Garnet.* This substance is not common in Essex county: a poor brown variety may be obtained at Crown-Point. Colophonite has long been known in Willsborough: it forms a vein in gneiss, with hornblende on one side, and tabular spar is intermixed with it. Light brown amorphous garnet is found at the same place. It is sufficiently abundant, but cannot be procured without blasting. In some parts of the vein, it is exceedingly beautiful.
10. *Tabular spar.* It occurs in a much finer state in Keene than at Willsborough. Near the former locality, I observed crystals of quartz, associated with a substance resembling prehnite, which I then supposed was new, and therefore named it *chiltonite,* but it is still a doubtful substance. These three minerals belong to the hypersthene rock.
11. *Eupyrchroite,* is the name I gave a mineral found at Crown-Point. Its name was suggested by its property of phosphorescing when slightly heated. Its light is a beautiful green, but quite transient. It appears from Dr. Beck's analysis, to be a phosphate of lime. It occurs in mammillary forms, similar to some varieties of malachite. It is green, but becomes pale, and even white on exposure to the weather. Though it does not occur under a regular form, yet it is a beautiful mineral.
12. *Brucite,* or *Chondrodite,* of a good yellow, in primary limestone, may be procured in Schroon, about one mile east of the post-office, on the road leading to Crown-Point. This is a good locality, though the quantity of the mineral is not abundant. Its color is finer than that in Orange county.
13. *Spinelle,* in small imperfect crystals. Color rose-red, but rather pale. They are not particularly important, except as furnishing a clue to better specimens. A few crystals of green spinelle, at East-Moriah, were found the second year of the survey; but after further search, no additional discoveries have been made.
14. *Tourmaline.* Brown tourmaline may be obtained at Schroon. The smaller crystals are nearly translucent. Two crystals were found with a greenish tinge upon the outside, and reddish within. This locality is worthy of a careful examination. Scapolite, brucite, reddish spinelle, yellow and brown tourmaline, are all obtained at the same place.
15. *Zircon.* Only a few crystals were observed in Schroon, near the locality of tourmaline. I found also at New-Sweden, on the Ausable, tolerable good specimens of zircon.
16. *Mica.* Six-sided tables of mica may be obtained also at Schroon, at the locality already specified. They are small, but transparent in a direction perpendicular to the prismatic axis. A blood-red variety has been found at Moriah.

17. *Idocrase.* This mineral occurs in very small crystals at Long pond.
18. *Sphene,* has been observed at several localities, as Moriah, Long pond and Keene.
19. *Phosphate of lime,* at Long pond.
20. *Proto-sulphate of iron,* in Westport, and small crystals of the common variety are not uncommon.
21. *Graphite,* usually disseminated in thin laminæ in primary limestone. It occurs everywhere in this rock. In addition to this form, it is found in a regular vein in Ticonderoga, varying from six to twelve inches in width, in gneiss. This vein contains it, in a very pure state; but it is wrought in the cheapest way. The walls of the vein are heated hot, and water thrown upon them in this state. In this way it has been explored to the depth of eight or ten feet, for ten rods. This graphite is manufactured into pencils of a very good quality.
22. *Sulphate of magnesia,* in efflorescences on the tertiary clay.
23. *Porcelain clay,* in Minerva.
24. *Hypersthene,* forming a constituent part of the rock of the same name. It forms, however, only a very small proportion of this rock.
25. *Pearl spar,* in small crystals, in the vein of black magnetic oxide of iron at Adirondack.

It will be observed, that the greater part of all the preceding minerals are contained in, or associated with, primary limestone. In this, and in many other facts which I have presented in this report in relation to this rock, we see its great importance, and the bearing it has upon geological phenomena.

The preceding minerals fell under my observation while pursuing geological investigations. I rarely turned aside for the purpose of searching for them; and considering the field, and the little time devoted to them, I hazard nothing in predicting that Essex will prove exceedingly rich in the department of mineralogy. A very large proportion of the surface of the county is still uncultivated; it has been examined only in a few isolated points; the inquiry has not been taken up systematically, and therefore we have reason to believe that many discoveries remain to be made. The hypersthene rock, however, which is so extensive, is not apparently rich in simple minerals. It appears to be an iron-bearing rock; but when we search for clusters, geodes or veins of crystals, we find them entirely wanting, with very few unimportant exceptions. The limestone, on the contrary, seems to be loaded with simple minerals, though not always fine, yet generally crystallized with several planes in great perfection, and with a fine polish.

Recapitulation of the leading Facts in the Geology of Essex County.

The principal feature in the geology of Essex, is the great development of the hypersthene rock, rising up apparently in the central part of a great chain of mountains, and forming the great nucleus around which all the other masses are disposed.

Another fact equally great, and more important, is the magnitude of the veins of iron ore. The greatest amount is connected directly with the preceding rock. I have spoken very indefinitely on the question whether they are veins or beds, partly for the reason that they appear to be contemporaneous masses with the rock itself, and partly because they seem to be closely

related to rocks, if they are not really to be considered truly rocks and constituent parts of the earth. It exists again in veins clearly so, but these are found in gneiss. We may notice, in some of them, a disposition to pass into a state of peroxidation.

Primary limestone occupies an important place in the geology of Essex county. I have regarded this rock as analogous to granite: the wide heavy masses as similar to the wide and extended beds of the ordinary granite, and the narrow vein-like masses as similar to veins of granite in gneiss. The wide beds in both cases are poor in minerals, and the narrow in both cases abound with them. In some instances, the narrow veins of limestone contain the same mineral species which have been ejected from volcanoes: thus, the pyroxenes and amphiboles, scapolite and phosphate of lime, idocrase, etc. are more common to thin limestones which occur in a mode similar to that at Long pond, than in the wide and extended masses.

The sedimentary rocks occupy only an extremely narrow belt along the shore of Lake Champlain; they exhibit some important facts. They are evidently broken from those rocks which are of the same kind, upon the east side of the lake. The lake lies in a deep rent in the rocks, which has been widened by the action of agents of a different kind. In support of this hypothesis, we find long narrow fissures in the hardest of the rocks, the potsdam sandstone, for example. The fracture of the rocks themselves, and their dip from the lake or fissures, is proof more positive.

The tertiary is another remarkable formation. All the facts connected therewith go to prove that it is very recent. Its beds are sometimes slightly disturbed; but whether from a general uplift, or from having been partially undermined, and a portion in consequence fallen down, cannot be distinctly shown. Hence, it is difficult to determine the question whether a material change has taken place in particular points since its deposition, or not. The general uplift of the country, since its deposition, must of course be admitted. There is no other rational mode of accounting for the drainage, and the displacement of the ocean, in waters in which this sediment was deposited.

The igneous or trap rocks never, correctly speaking, form extended masses over the surface of the county, except in one instance, namely, that of the porphyry at Canon's point; and this is comparatively limited. The trap dykes are far more numerous at the extreme points of the mountain chain, where they terminate upon or near the lake shore, as at Trembleau point, Port Henry, and Split-rock.

CLINTON COUNTY.

Mountain ranges; Valleys; Drainage.

The general features of Clinton county contrast strongly with those of Essex. By reference to the map, it will be seen that the Ausable river, though it rises in the midst of the Adirondack mountains, yet the large branches find a passage to the north of the main range, where they receive the drainage from this slope, and finally terminate several miles northward of Trembleau point. This is the last range which reaches the lake shore, and hence all that portion of the Second district north of the Ausable is comparatively level. Rising from the valley of this river, from Keeseville on the Plattsburgh road, the only mountains viewed from the sandy plain, lie far to the west and northwest: they are the ranges situated upon the western bounds of the county, between Clinton and Franklin. The distance of the highest from the lake is not far from twenty miles; and as they range parallel to the county line, and not far to the east of it, it happens, that almost the entire county is unbroken by mountain ridges. The rise is gradual, for example, from Plattsburgh to Saranac, near the base of the mountainous tract; and hence the whole county has a gentle slope to the east, and perhaps slightly to the north of east.

Between the termination of the great Clinton range on the southwest border of the county, in the direction of the Ausable, and the range of mountains already spoken of as extending on the western border between Clinton and Franklin, we find a wide field, which must in early times have been an extensive bay, sheltered on the southwest and west by the ranges of high land just described; and it must have been a bay of great depth, as in it we find a perfect development of the Champlain group, which as a whole is more perfect than has yet been observed in any of the New-York districts. Looking upon this field in this light, that is, regarding it as an ancient bay, (and I can find no ground for objection,) we can not but be astonished that the main features of this region should be preserved in a form, or in an outline which it had at the period when those rocks were deposited. While other parts of the earth's surface have been changed, the ancient barriers broken up or thrown down, here we find they have remained in profile much the same; raised up, it is true, but the uplifting has been so gradual, that the contour or shape of the ancient headlands are preserved.

While the truth of the above remarks will not be questioned, so far at least as claiming for the county freedom from mountain ranges as they exist in Essex, still I have no doubt a portion of it may be denominated hilly. The south and southwest is especially so; that part containing the iron mines, most of which are upon the highest of the hills in the vicinity.

The first eminence which I shall notice is Rand's hill. It is principally in the west part of Beekman, and is a long ridge, with moderate slopes to the east and north, and terminates in Chazy. It rises in Saranac. On the west side, there is a descent to the Chazy lake.

Ten miles northwest of Redford, in the town of Saranac, is Lyon mountain, an eminence between three and four thousand feet high. It is the most conspicuous mountain in this region. It lies partly in Franklin county.

Fellows mountain, which is another height in this group, lies between Rand's hill and the last named eminence. It is probably two thousand feet above tide.

In neither of these do we find any facts which call for a particular statement in a geological treatise. Their range is parallel with those which have already been described in Essex county; they terminate at the north in a gradual slope; and it is across and upon this slope that the common travelled road passes into Franklin county, over an elevation whose summit level is one thousand feet above tide.

From Rand's hill toward the east, no remarkable irregularities occur, but the descent to the lake is more than usual for the evenness of its grade. The deviations arise from long lines of gravel, washed up by the ancient sea, whose coast extended several miles west of that of the present lake.

Primary Rocks.

The consideration of these masses will necessarily be brief, in consequence of their limited extent, and the absence of leading interesting facts.

Dividing the rocks into two classes, the primary and sedimentary, the line of division, commencing at the south, runs from Keeseville to Redford, a direction nearly northwest; from Redford, it passes between Chazy lake and Rand's hill, and then with a circular sweep to Roberts' in Ellenburgh; and from thence about southwest to Malone, leaving the whole northern frontier underlaid with a sedimentary mass. On the west side of this line lie the primary rocks, and upon the east and north the sedimentary. The latter are therefore the most extended rocks, occupying at least three-fourths of the county.

Of the first class, gneiss is the predominant rock. Beds of granite often appear; but they are, as a whole, more limited and less important than gneiss. Hornblende rock likewise occurs associated with the one last named, and into which it passes by imperceptible degrees. Granite and gneiss both become iron-bearing rocks in this county; both abound in red or flesh-colored feldspar, and pass into each by imperceptible degrees. In the plains of the lower grounds, the rocks are very much concealed by drift; while upon the hills and higher grounds, they are well exposed. It is here that all the iron mines have been opened, for it is only upon the highest summits that the rock is laid bare sufficiently for examination; and besides, I have thought it highly probable that it is only upon the eminences, or high up the sides of hills, that iron occurs at all in this neighborhood. Neither granite or gneiss, in this county, is essentially different from what it is elsewhere; we may meet it in several varieties, differing from each other in the color and proportion of feldspar, in containing hornblende or mica, and in a variety of unimportant particulars. Omitting, therefore, all details of the primary rocks, I proceed to speak of the iron ores which they contain.

Iron Ores.

In the ores of this county, we have the same general arrangements as in those of Moriah in Essex. They are all distinctly veins, pursuing in general a strike very nearly coinciding with that of the strata enclosing them. They are not, however, coincident with the dipping planes, but cross them very obliquely. The walls are most regular, well defined, and the width well maintained. Their surfaces are often striated, or as if strongly pressed by a mass of the ore when pushed upwards. The veins are found both in granite and gneiss ; and so far as observation proves, their qualities are not altered by the rock. If any differences prevail in this county as it regards the constitution of the ores, they arise from the great amount of oxygen they contain ; as when taken as a whole, the veins more generally contain a greater proportion of the peroxide than of the protoxide. Some, in fact, are composed almost wholly of the former ; and as most of the veins in this neighborhood are easily wrought, I have reason for believing that they are constituted very uniformly of a large amount of highly oxidated ores. I have not, however, turned my attention particularly to this fact ; for it is a subject which did not present itself till recently, when the field work of the survey was closed, and I came to examine the specimens in the State Collection. One vein only had been examined with a view to test the question of its state of oxidation, and this was the Arnold vein, which, as it exhibited on mere inspection evidences of its chemical condition, I had satisfied myself in regard to it at the earliest opportunity presented for examination. But I have found that many of the decidedly black ores give a brown or reddish brown powder, an indication of a high state of oxidation. A fact which the bloomers always looked upon as an indication of good ore, is a red stain upon the rocks, or a reddish powder upon the surface of the ore ; and all experience amply confirms this fact, that it is a good ore.

I shall now take up in detail most of the important veins in Clinton county ; they are mostly in the south part, adjacent to Essex.

Arnold Veins.

There are four parallel veins crossing a high and commanding hill, the ores of which are known as the *Arnold ore*. It appears that the vein which was first opened was the richest, and gave in the first place celebrity to the ore. This became known as the *Old blue vein*, and probably, from its purity and value, has been of great use in giving an impulse to the manufacture of iron in this vicinity ; and so high does this ore stand in market, that the veins are leased at the rate of six thousand dollars per year.

The four veins are nearly, if not quite, parallel, but differ in width : the old blue vein varies from two to eight feet. It is readily distinguished by the eye from the other veins, being always of a bluish tinge, and very frequently iridescent with purple hues. Its streak or powder is red ; a fact which shows the state of oxidation. This vein has been worked to the depth of two hundred and sixty feet, and in length about eighty rods. Its course is north-

northeast, dip seventy degrees west-northwest. At a distance of half a mile from the main mining ground, in the direction of its strike, an opening has been made, which has disclosed ore of a quality similar to this ; thus furnishing a fact, showing the probability that this vein is extended thus far in this direction.

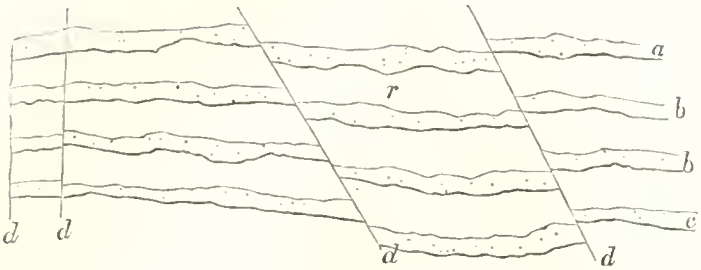
All the veins have been worked at different periods. The old blue vein was necessarily given up, in consequence of the falling of all the western wall for a width of six rods, and nearly the whole length to which it had been worked. The veins are called after the color of the ore : the first has already been given ; the second is a black variety, having a dull black color, but still it gives a brown or reddish brown streak, showing that this also is highly oxidated, a fact which would by no means be suspected from the color of the ore. This vein appears to be equally pure as the blue ; if any thing, it contains less quartz, and for aught which can be observed, it is as good. The remaining veins furnish a grey ore : this color arises from an intermixture of grey quartz ; and the ore, besides giving the red streak, is brownish upon the outside. All the veins, therefore, of the Arnold hill, are peroxides ; and being quite pure, and free from earthy matters, they may be worked without washing or any other separation. The grey ores contain the greatest amount of quartz, which is the only substance of a foreign kind contained in these veins ; and as experience has proved, it forms the most favorable flux for the perfect reduction of the magnetic oxide.

The Arnold ores are easy to reduce ; the iron is tough and soft, and is very much employed for nails, and all those articles where tenacity is required, and where softness is not an objectionable character ; for wagon tire, though it is essential that the iron should be tenacious, yet it wears out too rapidly ; neither is it so valuable for chains as a harder iron. This iron was at one time manufactured into cables ; but for some cause, it was acted upon by sea water more than the English cables, and hence became less saleable, when the business was abandoned.

The four veins upon the Arnold hill are in proximity to each other, being separated only by a few feet of rock. The width of the black vein is from three to eleven feet, and that of the grey veins from two to eight. The quality of the ore furnished respectively by each is very similar, and the products of reduction nearly the same ; preference, however, is given to the old blue vein.

In the progress of working them, several dykes have been encountered, which cross them at various angles ; and in one instance where the dyke is oblique to the direction of the vein, it has produced a shift ; that is, the portion included by the dykes has been carried the width of the vein to the east. This remarkable change I have illustrated in figure 76. Those dykes which cross the veins at right angles, have produced no change or shift ; while those which are oblique, have carried the veins several feet to the east.

76.



a, Blue vein; *b*, *b*, black, and *c*, grey veins; *d*, *d*, dykes; *r*, intervening rock. One of the dykes is ten feet wide, and its course is about N. 60° E.

Another, called *Indian vein*, was very early discovered on the Arnold hill, about fifty rods west of the veins just described. It pursues an easterly course, and if continued, would intersect the others some distance north of the place where they are now worked. The trials which have been made with this ore are unfavorable, and hence it has never been extensively opened. The most interesting fact is its oblique course and direction, being in this respect out of the usual range.

Reasons for the easy reduction of the ore of the Arnold vein.

The certainty of the process employed for the reduction of the ore of the Arnold vein, is a fact well established by long experience. Some cause connected with the nature of the ore, its formation, or its chemical constitution, must influence or bring about this result. The decision of this inquiry will undoubtedly be important, as it would throw light on the cause of failure in working other ores, and be the means of removing the difficulties sometimes encountered in their reduction. Analysis shows that what is usually called *magnetic oxide*, is a mixture of two species or kinds of ore, or iron in two states of oxidation: in one, the iron is combined with one atom of oxygen; and in the other, it is combined with two. This difference makes, with all mineralogists and chemists, two distinct species or kinds of matter. Chemical analysis proves also that the ore of different veins is not composed, with any degree of uniformity, of these two kinds of matter; but chemical analysis, while it proves both the mixture and the different amount of either in a given case, can never show us whether crystals of one of these bodies are distinct and separate from those of the other in the same mass: that is, if the usual method only is employed, if for example one hundred grains of the purest part of the vein is selected, pulverized, and then the full process of analysis is gone through with, such an amount of protoxide in the one hundred grains will be obtained; but it would not appear whether the particles of the protoxide and peroxide existed in small but distinct masses, or were uniformly blended together. Though this point cannot be determined by analysis, still it may be by the magnet, the protoxide alone being acted upon or attracted by it. Now experience has amply proved, that where the ore is composed of the two oxides,

the reduction is not effected so readily and perfectly as when it is composed of one. The cause of this difference seems to be owing to the following facts: — The protoxide first parts with its oxygen. After this change, when the ore has actually become iron, it is still necessary to continue the process, and the loup is not yet ready to be removed; for being still mixed with unreduced ore, it will not weld, and if taken out in this stage, it flies to pieces. Some portions, it is true, may now perhaps cohere under the hammer; but two-thirds of the mass will probably crumble, and be scattered about the premises mixed with slag. Now what is the consequence of exposing it still longer in the forge, until all the peroxide is reduced to iron? It is evidently this: the previously reduced ore is now exposed to carbon, and with this it combines, forming either steel, pot-metal, or a substance whose composition is intermediate between the two, or what is sometimes called *high iron*. The conclusion now which seems to be legitimate, is, that in attempting to work the magnetic ores, those which are composed of two species or kinds differing in their state of oxidation, more or less difficulty will necessarily be encountered, all of which will arise from the state and condition of the ore in regard to the unequal amount of oxygen different parts contain; one portion yielding its oxygen, and passing into the state of iron, before the other. When this is the case, both masses are then exposed without doubt to a series of complicated movements and changes, some of which serve to deceive the bloomer as to the condition of the loup, as to the time when it should be removed from the forge for hammering. Some of the ore is known to be reduced, but it does not all go down as is expected; and after waiting a sufficient length of time for the process to be completed, it is taken out, when very likely a few blows of the hammer breaks it to pieces, leaving perhaps one-third in the hands of the bloomer, which he is able to draw out into a bar. Whatever may be the result, after a part of the ore has been reduced as just described, namely, that part which is in the lowest state of oxidation, may we not infer, that as the remainder bears now a different relation to the agents employed in reduction, it will, instead of parting kindly with its oxygen, be more likely to combine with the earthy matters, and form various compounds which will go off in the form of cinder, or may it not affect the result in various ways? Whatever the result may be, it will be attended with a great sacrifice of ore; for if this is not true, how should it happen that three tons of ore are sometimes used in making one ton of iron?

I proceed now to speak more particularly of the Arnold ore, which I believe will throw some additional light on this matter.

This vein has long been celebrated for the iron which it produces, as well as for the ease and rapidity with which it is made. The question now comes up: To what cause or causes are we to attribute this result? Now this is one of those remarkable veins in which, while the ore externally bears the ordinary form and crystallization of the magnetic oxides, it is still internally a peroxide — a peroxide throughout; furthermore, it is remarkably pure and free from earthy matters. As it regards the first statement, perhaps I ought to modify it somewhat, as the ore may contain a small amount of protoxide; but this being the case, the quantity bears no proportion to the peroxide, and therefore does not modify essentially the result.

These statements being true, are we not in the possession of the cause or causes why the Arnold vein works so kindly, and produces such uniform results? First, it is a pure peroxide; and secondly, it is very free from earthy matters; and these two causes combined, seem to me to clear up the question very satisfactorily. But still more is this opinion sustained, when taken in connection with the statements I have already made in relation to those ores which are mixed. We find that they do vary exceedingly in the results of working, and occasion a variety of difficulties which have been exceedingly mysterious to the workmen, and which are not found to exist in working those in which the ore is in the state of peroxide.

On the probable success which will attend the working of the Arnold and other veins on Mr. Clay's plan.

The remarks in the preceding section were made with a view to reach the discussion of this question. This subject was introduced while upon the Adirondack ores, and would have been carried farther in that place; but I was at that time waiting for the result of some experiments which were undertaken by Mr. David Henderson, at his works at the above mentioned place; and since those remarks were penned, I have received from him the result of his experiments.

Now, as has been stated, Mr. Clay's plan of reducing the rich ores consists in deoxidizing them by means of charcoal; and it appears that his experiments were made upon an ore in a state of peroxidation. This being the case, it is important to bear it in mind; for there is but one mineral substance, as it were, to be acted upon; one in which the relations to all surrounding agents are the same; each particle having attained to that state which is usually termed saturation, will, when exposed to caloric, to carbon or atmospheric air, be ready to act equally and reciprocally. If this kind of ore is put into a covered crucible with fine charcoal, it will part with its oxygen equably; no part having an excess of oxygen over another part, each will in the same time be deoxidized, or be brought to the state of metallic iron; and when this is done, the process may be stopped. Now the Arnold ore, from its composition, is in the state to be reduced economically by this method. So perfectly is it a peroxide, that it might at once be deoxidized; and being also a very pure ore, that is, free from stone and foreign matter, the amount of slag would not interfere with its welding. I have no hesitation in recommending this mode of reduction, especially as this section of country is liable to a failure in wood, and the price of coal has now increased so much as to diminish the profits on the iron produced.

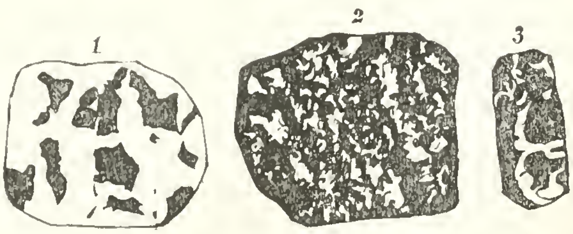
Having said thus much of the Arnold ore, I return to the inquiry in relation to the probability of employing the magnetic ores, which are mixtures of the two oxides; and here we shall probably find the same difficulties in reducing them by Mr. Clay's method, as in the forge or furnace. Proceeding without conjecture, I will go on and state the experiments of Mr. Henderson on the ores of Adirondack. These ores, as already stated, are mixtures of the two oxides; but before I proceed farther, I will state what appears to be the fact in regard to the distribution of the two minerals in the same mass, and the differences which prevail in different veins.

In the first place, then, the protoxide and peroxide exist in different particles, or rather crystals, in the same mass ; and their differences are often so well marked, that the peroxide can be selected by the eye, the lustre and structure being sufficiently different to enable one to see what parts are in a state of low oxidation, and those which are highly oxidated : the latter are in laminated masses, with brilliant surfaces, while the former are of a dull black color ; the former gives a brown streak, the latter black ; and if we resort to the magnet, the bright laminated particles are uninfluenced, while the dull black ones immediately obey and are taken up. It is therefore not as most chemists and mineralogists have conjectured, an intimate mixture or blending of particles, but an irregular mixture of the two, in separate and distinct crystals.

Again, by observing the characters of the two oxides, we may satisfy ourselves that in different veins the two oxides are entirely in different proportions ; and this fact led me to remark, that one object in pursuing the chemical examination of the magnetic ores, was to bring out and establish this same fact in every case, or to ascertain the proportions in which the two oxides were combined in different veins ; for we now see that the proportions may influence greatly the mode of working the ore, and may lead to new methods : those which are composed largely of the protoxide may not only work very different from those which are peroxidated, but, without being particular, a variety of important facts will grow out of this alone. It is not a matter of so much importance to determine how rich an ore is, or how much metal it contains, as in what proportions the two oxides are mixed, and which one predominates over the other. I am satisfied that every vein will be constant in its proportions.

Now the experiments of Mr. Henderson with the Adirondack ores, by Mr. Clay's plan, resulted in a manner agreeable to the tenor of the above remarks. His manipulations consisted in exposing the ores in a broken up state, without roasting, to pure charcoal in a *siggar*, a kind of crucible, for thirty hours, at a red heat, and excluding atmospheric air. On inspecting the pieces after filing and polishing, two different colors or appearances presented themselves. What is described as the coarse black ore in this report, became mostly metallic iron, as appeared by the filing, etc. ; but small black crystals were disseminated in the mass : these were brittle, but obeyed the magnet ; while the former received the polish of iron, was malleable, and hence was truly iron. In the annexed figure, Nos. 1 and 3 represent the

Fig. 77.



arrangement in these pieces. Now in this case, a large proportion is reduced, and it is that part of it which was in a state of protoxide; while that which is now black and brittle, and was bright and shining before the experiment, was the peroxide, and it is now merely reduced to the state the former was in before the experiment. But, inquires one, why not continue the process till the whole is reduced to iron; why stop it in this stage? The reason is obvious. The iron already reduced, being in contact with carbon, will not remain quiescent. It now has an affinity for carbon, with which it will combine at any rate, and cannot be prevented. And this accords with experiment; for on suffering some siggars, with their contents, to remain seventy or eighty hours, the iron shows its carbonization by its softness, and soiling slightly either the fingers or white paper. This, though it upsets the idea of reducing the two oxides when mixed, yet is an interesting fact, and may possibly, if carried out, lead to the manufacture of steel by a method more expeditious and less expensive. The iron is, as it were, in a nascent state; it is, from its porosity, in a condition to combine with carbon; and the end in view, in order to secure a favorable result, is to know when to stop the process: the iron seems, too, to be in a state to receive the carbon into its whole texture — to be ready and prepared to form a compound with carbon, in which the latter shall be equally disseminated through the mass.

By reference again to Fig. 77, No. 3, we have a visible representation of the proportions of the oxides in the coarse black ore, and the same proof exists previous to experiment. The bright particles of peroxide have the same relative proportions, and the only differences which exist are the changes in the chemical constitution, each oxide having lost one atom of oxygen.

In the same figure, No. 2 is a specimen of the fine-grained ore; and here we see not only a different arrangement of the particles of the two oxides, but different proportions also; here the peroxide is greater in quantity than the protoxide. The same changes have followed, however: that which was black in the ore, and of a dull lustre, has become iron; while the bright particles are only reduced down to the state of a protoxide. In the fine-grained ore, it is more difficult to distinguish the oxides before the reduction, than in the coarse black ore; still, by receiving the light properly upon the specimens under examination, the one is sufficiently distinct from the other.

Another inquiry might be made in this stage of my remarks: Can not the deoxidized ore be put at once into the forge, and the last process be facilitated in this way? This question is equally clear with the one above. Exposing the mass in any way to carbon when heated, will make a carburet; and to verify this conjecture, Mr. Henderson put a quantity into the forge, giving his bloomer directions to run it down as rapidly as possible. These masses all came out malleable, though immensely hard, and formed exceedingly tough bars, some portions being in the state of steel, and others iron. For some purposes such a mixture may be very useful, combining the toughness of iron with the hardness of steel.

In addition to the above, Mr. Henderson informs me, that on referring back to former experience, he believes that all the bars which have been made from the coarse black ore were mixtures of iron and steel. Some of them were remarkable for their toughness and obstinacy,

and the tools made from them bore harsh usage. Now it is to be borne in mind, that the greater proportion of this kind of ore is in a state of protoxide, which being reduced first, finds means to combine with the vapor of carbon and form steel; and it is not impossible that this state of oxidation may be better suited to the manufacture of steel, than the higher states of oxidation.

The importance of the preceding facts can not be well estimated, except by those who have experienced the difficulties of working the mixed oxides. Some have been toiling and searching for some poisonous substance in the ore; some have been examining the kinds of earth mixed in them; while others have been trying various fluxes, to secure a uniform fusion, or to form a slag which should cover the reduced ore and prevent its combining with carbon. Various expedients have been resorted to, all having the same end in view; but no one thought that the different degrees of oxidation might be at the foundation of all the difficulties. Such, however, is the most rational theory; a theory which, it seems now, might be supported by an *a priori* argument, but at any rate is sustained by experiment. The credit of this discovery is due to Mr. Henderson, who, with great perseverance in experiments conducted for two months in trying Mr. Clay's method, has conclusively shown not only what were the causes of all former difficulties in working these ores, but what will be essential to complete success in working them hereafter.

After the preceding remarks and facts, it will appear to reflecting minds that all that is essential and requisite to make good iron of these mixed ores, by any of the methods now in use, is to separate the two oxides by the magnetic machine. This is all that is essential. It will undoubtedly be useful to roast the ores in the first instance; for by this process, some portions lose sufficient quantity of oxygen to become magnetic; the magnetism of the whole seems also to be stronger after roasting, than before. This operation not only separates the two oxides, but separates also the pure ore from rock and earth. The latter in certain proportions is not specially injurious in the forge; but when Mr. Clay's method is contemplated, the purer the ore is, the greater is the certainty in the last process. When the ore is a peroxide mixed with stone and earth, and needs separating, the washing process will probably be the most suitable, or the cheapest. I find it is preferred by several gentlemen in the iron business, who have tried both methods. The magnetic machine is capable of separating six tons of ore per day, a quantity which is sufficient to supply a forge for one week.

Rock investing the veins of the Arnold hill, and its simple minerals.

The rocks immediately investing or embracing the veins described in the preceding paragraphs, is a deep red granite, though the rock of the surrounding country is generally gneiss. The deep color of the granite appears to be partly owing to the great abundance of the peroxide of iron in the immediate vicinity. Near its junction with the ore, it is traversed by thin veins of feldspar, of iron, granite of a different kind from that of the main rock, jaspery iron, etc.

The simple minerals associated with the ore, or embraced in the rock, are by no means

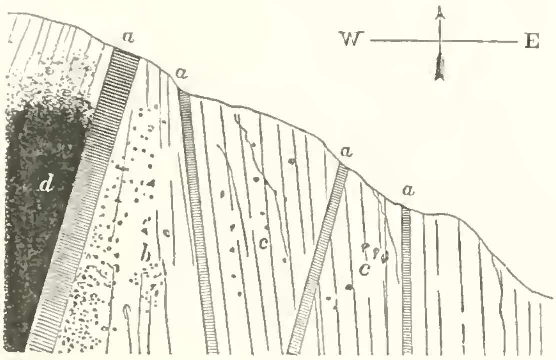
numerous. Small quantities of green and purple fluor, sulphuret of iron, a few crystals of lime, comprise the principal simple minerals at this locality.

The arrangement of the substances constituting the veins, as well as those adjacent to them, is in alternating layers. Numerous specimens are deposited in the State Collection, illustrating their order.

Palmer Vein.

The history of the working of this vein is interesting, on account of the difficulties which have been experienced in finding the main vein. Ore disseminated in the rock had been raised for many years, but the quantity varied greatly, and generally it was too lean to be profitably worked previous to the discovery of the regular vein. The difficulty of finding this, arose from disturbances by dykes. The following diagram will explain the points which I wish to

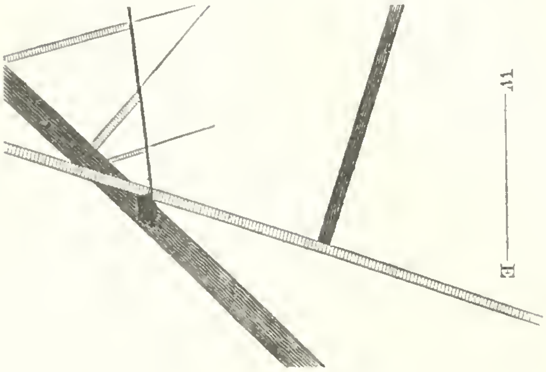
78.



present and illustrate: Fig. 78 is a vertical section of the rock, dykes and vein; *a, a, a, a,* green stone dykes; *c, c,* spaces between the dykes, in which ore is disseminated in the rock; *b,* ore, in greater abundance; *d,* the main vein. In the space *b,* for a number of rods north and south, ore had been raised; but it was uncertain in amount: sometimes for a few feet it was rich, and again it became lean and unprofitable. After raising all which was at all possible on the score of economy, up to the wide dyke, it appeared necessary to abandon the vein. It was, however, proposed to cut through the dyke, which was known to be fourteen feet wide, and see what was beyond it. The result was the discovery of the main vein. At the time of my visit, it had been opened about thirty-five feet, which appeared to be then its thickness. A fact worthy of special notice, is the great amount of ore, but a small distance below the surface; while but a small quantity, in distant particles, appeared in the rock upon the surface. In fact, passing over the vein, no indication of its existence can be discovered in the rock, except a few scattered particles of ore. To illustrate the interesting relations of

the veins and dykes still farther, I have introduced a ground plan, Fig. 79. The dark shaded

79.



lines are the veins as in the preceding figure, excepting the thin one, which represents the road that was cut into the rock, and which divides or cuts the four veins successively, and terminates in the thick mass of ore beyond the fourteen foot dyke. The latter may be traced half a mile south, where it meets and cuts another large vein of ore, which I shall have occasion to describe hereafter. This large dyke cuts the Palmer vein very obliquely, while it crosses the same half a mile south at a right angle. I was unable to satisfy myself whether the Palmer vein is really shifted out of its course, or not.

The reader will observe some very remarkable features in this, which are not found in the Arnold vein, particularly in the wide dissemination of ore in the rock, and the absence of regular walls. In the Palmer vein, the distribution of ore has a nearer resemblance to the Penfield vein, described under the head of Essex county. In both of these instances, and with them might be included the Adirondack ores, it seems that the distribution must be coëval with the formation of the rock. We do not find those peculiar marks of violence and force, where the vein and rock come together, as in the Arnold and some other distinct veins. Farther exploration may throw some light upon the subject, and determine the question whether such instances as the Palmer ore should be called a vein, or a mass.

The Palmer ore is black, and mixed with a grey quartz. It requires separating before it is reduced; and in this process, it loses about one-third of its weight. The rock embracing it is gneiss of the ordinary grey color, but without any very remarkable characters.

Quality and quantity of the Palmer ore.

Experience has proved the value of this vein; and though it is not so rich as the Arnold, yet it is profitable to work, and furnishes a good iron. In consequence, however, of the proximity of the latter to the Peru iron works, the proprietors, though they own the Palmer vein, find it more profitable to use the Arnold ore at the rate of five dollars per ton, than to work their own. It is, however, used more or less, mixed with the Arnold ore, for the purpose of

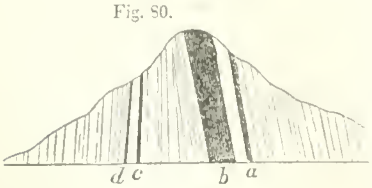
making a harder iron, by which it is adapted to a greater variety of purposes, as horse-shoes, wagon tire, chains, etc. From the abundance of quartz in the Palmer ore, it requires washing before it is reduced, which is one of the principal reasons why the Arnold is preferred to it at a stated price.

If the opinion is correct, that in piercing the fourteen foot dyke the main vein was reached, then there can be no doubt that the quantity of ore is inexhaustible. That part of the mass which was pierced upon the west side, measured thirty-five feet from southeast to northwest; a direction which appeared, at the time of measurement, to coincide with a transverse section of the vein. The eastern wall, however, is formed at this place by the dyke, from which the ore cleaves with perfect freedom, leaving a naked and smooth surface. The opposite wall is formed of the rock, to which the ore adheres somewhat unequally, leaving an irregular uneven surface. Still the surface exposed bore some of the general characters of a wall. The question, however, could not be determined until the working had proceeded farther. The vein upon the west side appears to dip in that direction, or the ore goes downward with increasing width; but whether it is a true dip, or a widening of the mass, could not be determined. Should the owners of this vein continue to work it, some interesting facts will be disclosed hereafter, particularly in regard to the relations of the magnetic oxide to the rock; for though I have spoken of this and many other instances of the mineral existing as an ordinary vein, yet the word has been adopted partly from convenience; for neither the term *vein* nor *bed* appears to express the true relation to the rock.

Cook Veins.

The Cook veins traverse a sharp high ridge three miles northwest from Clintonville. One of the veins was worked by the Peru Company, many years since; but as it was only two feet wide, it became too expensive after working it to the depth of fifty feet, and it was abandoned. Afterwards the owner, Mr. Cook, in attempting to lay open this vein by a transverse section through the hill, discovered three other veins running nearly parallel with the old one, making in all four veins, with the following amount of width: one of two feet; one of three; another of six; and lastly, one of thirteen feet. Their general relation to each other, and to the rock, appears in the annexed diagram, fig. 80. The wide vein is only five feet west of the narrow and inconsiderable vein, which had been explored for several years. The discovery of these veins was made by a transverse section spoken of above. And here it is proper to remark, that in opening mines, sections crossing their strike ought always to be made, especially when it is probable that others exist in the vicinity; and besides the chances of discovery, this mode of opening facilitates drainage, and the raising and removing of the ore. Sinking perpendicular shafts, or following a mass in the direction of its strike, generally results in loss and disappointment.

Fig. 80.



Quality and quantity of the Cook ore.

The ore of the Cook vein is black. Some parts of the vein are granular or soft, as this state is usually called by miners; other portions are compact, or in firm masses. It is a rich vein even near the surface, and it improved as the excavation proceeded downwards. It is not, however, so pure in the vein as to admit of smelting previous to washing. Its gangue is quartz or flint, black mica and hornblende. Its supporting rock is granite. The course of the vein is north and south. Parallel with the thirteen foot vein, which is to be considered as the main vein, are three others; one of six, one of three, and another of two feet. The hill on which these veins are found, is two hundred feet above the plain. Its location is therefore quite favorable for mining operations, as it will be for a long time easy to drain, and convenient for removing the ore.

The iron made from this ore is of the first quality. Along with hardness, there is sufficient elasticity and toughness to make it valuable for spikes, horseshoes, bands and nails. The grain is fine and bright, with a clear metallic lustre; it hammers very smoothly, and presents a very fine even compact surface. In fine, it resembles very nearly the old *Russia sable*, so celebrated in this country. The ore makes iron fast; and considering all its properties, it must be considered one of the most valuable veins in the county of Clinton.

In estimating the quantity of ore which the Cook vein may yield, it is proper to take into the account the four parallel veins. It will be seen that their aggregate width is twenty-four feet. These several veins are so near each other, that by transverse cuttings, all of them may be worked as one vein. The examination of the vein proved also the increase of ore downwards, an increase produced in part by an increase of the width of the vein, and also by the disappearance of the stony matter in the vein. The arrangement of the ore and earthy matter is mostly in vertical parallel bands or stripes. It is evident, in many instances, that there is a larger amount of rock in the vein near the surface. This was evidently the case with the Cook vein, though it would not be an uncommon circumstance if the predominance of earthy matter should be found restored deeper in the vein. Still the indications were favorable to an increase of ore, rather than a diminution of it.

The Cook vein may be traced in a northerly direction by the masses of ore at the surface of the rock, for one and a half miles. At its extreme northerly boundary, it appears again in heavy masses, and has there been opened by Mr. Stone, and is now successfully and profitably worked. The ore of this vein is highly magnetic, and possesses polarity distinctly. This is a property, however, which is more frequently possessed by that portion of the vein above the surface of the rock, or that portion which has been exposed to light. It often happens that ore which is raised from a depth of twenty-five or thirty feet, exhibits at first neither polarity nor magnetism; but after exposure to light and atmospheric agents, this property is strongly developed; indicating, it would seem, some connection with imponderables as light, caloric and electricity, at the surface, which does not exist far beneath it.

From what has been said, it will be seen that the quantity of ore which the Cook vein is capable of furnishing, is all that can be wished. Its breadth and prolongation northwards show conclusively that, for a long time, it will be accessible without deep excavation.

This consideration I have thought proper to introduce, inasmuch as it bears on the permanence and stability of the manufacture of iron, and the expediency of permanent improvements. If the veins of ore in a given section of country are soon to be exhausted, then there is no occasion or no propriety in making extra expenditures to facilitate the transportation of heavy articles. On the contrary, if these collections are inexhaustible, then they constitute a permanent source of wealth and income to the country, and which may be increased by facilities for transportation, without danger of finally losing value from want of articles to transport.

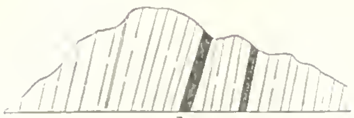
The Cook veins, in their northern prolongation, are traversed by several dykes; and though the ore in this prolongation appears only in disseminated particles, sometimes more and sometimes less, still, in my mind, there is little doubt of the real prolongation of the principal vein. The dykes appear to be parallel to each other, and pursue a course about N. 50° E.

After leaving the site where these veins are more successfully explored, we rise to a higher level. Now, in many instances, when ore is disseminated in the manner we find it north of the actual veins, they have been found to be continued by a sufficient removal of rock; and the probability of finding it in a body at any point along this range, is strengthened by the fact, that the Battie vein crops out to the north at a lower level; for the vein appears to traverse the ridge rather obliquely, making a continual westing till it reaches the western slope, when, at a considerably lower position, the veins appear in the rock. Now it is probable that at any point between the Battie and Cook veins, the ore will be found by sinking a shaft to the level of either, or by removing what is called by miners *the cap of the vein.*

Battie Ore.

The Battie vein is to be considered as a part of the Cook vein. It is distant from the latter one and a half miles, and from which it may be traced by surface ore. The vein has been exposed in two places; the most southerly was mixed largely with iron pyrites, especially the portion adjacent to the eastern wall. It is not so highly charged as to prevent its use in the furnace; but for bar iron, it proves brittle. On account of the injurious mixture of pyrites in the southerly opening, the vein was sought for twenty or twenty-five rods further north, when it was found to be well developed near the surface. This last opening was just made at the time of my examination, and the true character of the vein could not be determined; still, there was a width of thirteen or fourteen feet of vein, mixed with rock composed of flint, hornblende and black mica. Thick solid masses of ore, free from pyrites, were found traversing the vein longitudinally, somewhat wedge-form in shape, with the thicker portion downward, indicating an increase of ore in that direction, and the disappearance of rock from the vein. It is proved by reduction to make an iron similar to that made from the Cook ore; which, as has already been stated, is of the best quality.

81.



a, *b*, veins corresponding nearly to the dip of the rock.

Two veins only have as yet been discovered at the opening which is called the Battie vein. A want of perfect parallelism in the Cook veins may explain this fact, though it is not proved that the narrow veins extend far north of the opening made by Mr. Cook. They dip to the east at a high angle. Their relations to the rock are explained by fig 81.

About fifteen rods farther west, is another vein of iron, with a gangue of pure white flint, which I examined, and which may be traced thirty or forty rods. The ore is black, and constitutes about one-third of the vein at the surface. By the encouragements which were given, this vein has also been opened, and presents favorable indications of being a valuable deposit of ore. The presence of white flint is always regarded as an important substance in the magnetic oxide, particularly as it becomes a valuable flux in the process of reduction. This vein varied from four to six feet in width at the surface ; and I am informed since my visit, that not only the proportion of ore increased, but the vein also increased in width.

Rutgers Vein.

This vein is eight miles west from Clintonville, and like most of the veins in this vicinity, occupies a ridge of one of the primary ranges. It has not been explored to a great extent. Its appearance is lean at the surface, but no more so than many veins which, by farther pursuit, have proved to furnish an abundance of ore. The gangue or mineral matter associated with the ore is very peculiar. It has a resemblance to phosphate of lime, but so peculiar, that without analysis, it would be hazardous to decide. It is quite abundant, but still distinct crystalline forms are wanting. Sulphate of barytes is also occasionally mixed with the ore, a substance which I have not observed at any other vein of iron in this vicinity, though it is one of the constant associates of the specular oxide in St. Lawrence county.

The whole width of the Rutgers vein is about ten feet. It pursues a parallel course with the Cook and Arnold veins, and has been traced about one mile. It is probably an extensive vein. It has not furnished an iron so valuable as most of the other ores ; and has therefore been abandoned.

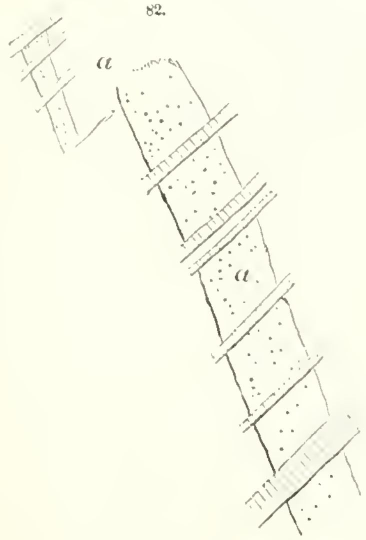
Winter Ore.

This ore has generally been considered to be deposited in the form of a bed, in consequence of its appearing as a thick plate overspreading several square rods of the rock with which it is associated ; or it appears as though it was deposited horizontally on the rock, like an overflowing melted mass of lava. The opinion that it is a bed is questionable, inasmuch as it presents no phenomena really distinct from the ordinary veins of this section of country. The rich layer of ore was two or three feet thick ; but it does not disappear beneath, but is underlaid by rock in which the particles of ore are disseminated. The whole amount of valuable ore extended forty feet in one direction, and one hundred in another. The whole of

this mass has been removed, and the surface now exposed presents an unequal distribution of it, but in no place an amount worth the expense of raising. It presents, however, the same general arrangement as all other veins, that of parallel bands or stripes. In some portions the ore is in the proportion of one half, the other half being white flint. Considered as a vein, its strike or course is west of north, or N. 10° W., and its dip west. Ten or fifteen feet beneath the solid plate of ore, a passage has been made in the solid rock for at least one hundred feet. It commences on the northern slope, and runs nearly south. No ore was discovered by this procedure, and it could not have been reached, even if there is an abundance of ore, in consequence of the dip of the vein. The entrance into the rock being made on the eastern side of the vein, and parallel to its course, the adit or drift seemed to be beneath it; whereas if the drift had been made east and west, it would have crossed it at a point west of the present drift.

The great difficulty of obtaining ore at this place, is probably in consequence of the great derangement produced by several transverse dykes. In the distance of one hundred feet on the line of the ore, there are nine dykes, a ground plan of which I have given in the following diagram (fig. 82), from which we have a strong probability that they have had more or less to do in obscuring the true relations of this mass of ore. The dykes vary in width, but their several courses are parallel. Their directions are N. 55° E.

82.



a, a, Main vein traversed by several parallel dykes.

The relative position of the four veins which I have now described, may be illustrated, as a whole, by the following section. They lie nearly in the same east and west range, pursuing in general a course nearly north and south, while the ridges upon which they outcrop strike north-northeast and south-southwest.

83.

1, Winter vein. 2, Cook vein. 3, Arnold vein. 4, Palmer vein.

The valleys between are deeply covered with drift, concealing in a great measure the rock beneath.

Mace Vein.

This is a vein which is newly discovered, and has not yet been opened to an extent which admits of a thorough examination, at the surface it is well characterized, and is four feet wide. The width has increased since it has been worked. It pursues the same northerly direction as the other beds, and its dip is to the west. It may be traced by the masses of ore in the rock, twenty-five or thirty rods. The ore being rich in the vein, and associated with flint, furnishes good evidence of a valuable vein. It is about two miles east from Clintonville, and is easy of access. It furnishes a valuable addition to the stock of ores in this vicinity.

Burt Vein.

This is a hard ore, and requires only a passing notice. In the trials with the ore, it was found to reduce easily; but when put under the forge hammer, the loup broke in many pieces. These, when again put into the fire, welded, and came out good iron. The ore is fine grained, with a strong metallic lustre. It is tough, and contains much sulphuret of iron. Still, those unaccustomed to the business of smelting ores, would consider it as one of the most valuable of this species. Generally, those ores which have a bright lustre, and are tough or difficult to break, are to be ranked among the poorest of ores; while those with a dull lustre, accompanied with friability, are as generally good.

The Burt vein is eight feet wide, but is mixed largely with feldspar. Its direction is east and west. The ore is disseminated in it in masses of several pounds weight.

Jackson Vein.

This vein I consider a continuation of the Arnold ore, as it is in the direction of its course, on a hill of the same elevation, and only a mile or a mile and a half distant. The vein is quite distinct, but was not opened its entire width. The quality of the ore is unquestionably good, and there is no doubt of its abundance.

Finch Vein.

This is the southern prolongation of the Arnold vein. It has furnished a large amount of ore for the forges in the vicinity of Clintonville. The character of the ore is much the same as the grey and black veins of Arnold hill. It is not worked at the present time.

McIntyre Vein.

This vein, though situated on the same hill as the Palmer ore, cannot be considered as a part of the Palmer vein. It is on the south face of the hill, and has a course about northwest. It is a new vein, and has been explored to a small extent only ; but from its appearance, the indications for a valuable ore, and abundance of it, can not be doubted. It has a width of from six to ten feet. Many parts of it, as now exposed, are the soft granular varieties. So far as I observed, sulphuret of iron is not present in the ore. It is associated with black mica, hornblende and quartz. For reduction, it requires either separation of the earthy matter by washing, or by the magnetic machine.

Entire width of the veins in the Clintonville district.

The preceding account of the iron ores in the vicinity of Clintonville, is drawn from facts and observations which were made during the summer of 1839. The entire width of all the veins which I then examined amount to one hundred and thirty-six feet, after excluding the Burt and Winter veins. Some of them are new, and have not been opened sufficiently deep to reach their most valuable parts. Many of them are the richest ores in this country, the Arnold alone being sufficiently so to be reduced directly without a separation of earthy matter. Those which have been described, are in the circuit of six or eight miles of Clintonville.

It must be confessed, however, that in consequence of the consumption of wood, the prospect for the future is not so cheering to the enterprising manufacturer of iron, as could be wished. Unless means of communication are furnished to the wooded districts of the Saranac and Upper Ausable, the present highly flourishing establishments for the manufacture of iron must in time be abandoned, and, as it would appear, at a period when the demand for it will be greater, and when every attending circumstance will be favorable to the production of a better material at a diminished cost.

The amount of ore is inexhaustible, and it is quite accessible. Its value at the mine, after it is raised and dressed, varies from four to six dollars. The establishments for this manufacture are increasing. Though they are generally small, still they are profitable ; and could the forest at the western boundary of the county become more accessible, it would be all that is required to give perpetuity to the present establishments, and also encourage many more, all of which could not fail of making this district one of the most flourishing in the State.

Veins of Iron Ore west of Plattsburgh.

An important vein of magnetic oxide of iron exists about twenty miles west of Plattsburgh, and seven northwest of Cadyville. It is a distinct vein in reddish granite, whose structure is unusually coarse for the granite of this region. It is black, and quite pure ; in parts of the vein, the outside is mixed largely with decomposing feldspar. The ore itself is coarse, and

is readily reduced to a state fit for smelting. It is mixed with hornblende, and a small quantity of a reddish mineral which has some resemblance to phosphate of lime. Still, we observe none of the effects of this substance in the iron. This ore makes a tough iron, suitable for chains, horseshoes and nails, hoops, etc., and all those purposes where a hard tough iron is required. Some portions of the vein furnish an ore resembling the grey ore of the Arnold vein, but the iron is like that obtained from the Cook ore.

Sailly and Averil's vein. This ore breaks into angular fragments or masses. It is fine grained, and intermixed with greenish matter which appears to be pyroxene. It contains some sulphuret of iron, and the ore is brighter than that of the vein just described. It contains about one-third of its weight of earthy matter. Its matrix is also a red coarse granite, in which large crystals or masses of feldspar are quite common. From the general character of the ore and rock, it seems to be a continuation of the preceding vein.

These veins are favorably situated for the manufacture of iron, being only about three miles north of the Saranac, where there is abundance of water power, and in the midst of a country abounding in wood.

LOWER MEMBERS OF THE NEW-YORK SYSTEM.

The great development of the lower members of the New-York system, is the most distinctive characteristic in the geology of Clinton county. The series extends from the Potsdam sandstone, to the Utica slate. Between these extremes, several thick masses occur, which do not appear in other parts of this district. It will be my object to give a full view of the rocks, as they are here developed. The most important and interesting fact is the addition of beds to most of the rocks, which rarely, if ever, appear in other places where the same rock seems to be fully formed. For example, the calciferous has many additional beds, some of which might be separated from it and placed among the rocks; the birdseye contains many feet of a drab-colored rock, quite distinct in mineralogical characters from the birdseye itself; and the chazy limestone, too, is a much thicker rock here than elsewhere. But leaving these peculiarities to be more distinctly noticed in another place, I will proceed in the usual order, and describe first the potsdam sandstone.

This rock, where it enters Clinton from Essex county at the south, is continuous for about seven miles. From near Keeseville upon the Ausable, it lies above, and rests upon the primary, and extends in a northwest direction to Redford. From the latter place, it runs nearly north over and in the direction of Rand's hill, to Ellenburgh. The width of the belt occupied by it is scarcely less than fifteen miles in the central part of Clinton, or from Plattsburgh west. From Lake Champlain to the extreme west border of the calciferous sandstone, does not exceed in any place four miles; and the remainder of this county, then, from the latter rock to the western limit of the potsdam, is nearly the distance already stated. In this space, it is often concealed beneath thick beds of drift; in which drift, too, a great abundance of rounded masses

like paving stones, and derived from the potsdam, are mixed. In other places the rock is very much exposed, as upon Rand's hill, where it is laid bare, and without sufficient soil to support any but the smallest shrubs, except where they take root in the cracks or natural joints of the rock. This rock, too, furnishes two or three varieties which I have not recognised in other places.

1. The ordinary fine-grained, grey or brown sandstone, crystallized on a large scale, in coarse rhombic prisms, similar to the rock at Keeseville.
2. Deep red sandstone, stained with oxide of iron; it occupies the lowest position. About ten miles east of Plattsburgh on the Military road, and in West-Chazy two miles southwest of Lawrence corners, this variety is common, forming the lowest layers of the rock.
3. White granular and friable sandstone, in the town of Mooers. Sometimes it has the whiteness of loaf-sugar, and disintegrates into sand; it is a fine material for flint glass.
4. Dark iron-brown or black sandstone, traversed by seams of quartz; it resembles, as a whole, some of the varieties of greywacke. It forms one of the masses at Chazy. It occupies a superior position in the rock, and in conjunction with the succeeding, is not less than one hundred feet thick.*
5. A brecciated mass, associated with the preceding. It contains fragments of limestone, resembling the calciferous sand-rock.
6. Conglomerate, which usually occupies the lowest place; but on the northwest border of Clinton, the whole mass partakes of this character.

This rock extends two miles west of the Redford glass-works. At this place it is probably separated from the main mass by a range of granite, which extends through Saranac, and from thence northwards several miles in the rear of Rand's hill. Although this rock is of the common grey variety similar to that at Port Kent and Keeseville, still it burns white, and is employed almost exclusively in the manufacture of the Redford crown glass, which has become known to community for its beauty and strength. Probably most of this rock is suitable for this use. It is the common rock which is employed, though in Mooers a fine white variety is abundant. It is essential, however, that it become white in burning.

Of the varieties described above, Nos. 4 and 5 appear to be entirely local. I have not seen them except in Clinton. The others are common.

I had occasion, when describing this rock in Essex county, to speak of the remarkable gorge at Keeseville, and through which the Ausable flows. A still larger fracture exists in this rock near the Provincial line; or it is said that the boundary passes through it, the town of Mooers being south, and Canada north. However this may be, the place itself is very widely known under the name of *Flat-rock*. Covey hill is sometimes spoken of as the place where this fissure occurs. It is sixteen miles west from Champlain.

The fissure, or *gulf*, as it is usually called, is three hundred feet deep, and about sixteen rods wide. Its walls of sandstone or conglomerate are perpendicular at the deepest part. The small lake at the bottom is said to be one hundred and fifty feet deep. The direction of this fracture is north seventy degrees west, and the rock dips at a small angle from each side of

* Boulders of this mass are scattered over the fields in this town. There is one, half a mile southwest of the village of Chazy, twenty-five feet long, twenty wide and eight thick.

it. Hence it appears to have been formed by a partial uplift, sufficient to fracture the strata, and give them a slight inclination to the north and south. At the present time, however, no causes are in operation sufficiently powerful to remove the broken masses from a gorge of this description. At Keeseville and Cadyville, large rivers, the Ausable at the former and Saranac at the latter, still occupy these gorges as their channels, and have sufficient force and power to sweep out, especially in the time of high water, all rocks of an ordinary size. At this place there is merely a small rill discharging itself from a small lake of dead water, insufficient in itself to accomplish any perceptible change. To account for the present condition of this rock, we have therefore to go back to a period when some current swept through this gorge with great force and power; for, by no other means could the materials, which once filled the space between the present walls of the gulf, be removed.

In Cadyville is another gorge of this description, but its width is much less. It is a mile and a half long. The Saranac flows through it, and it has a fall of forty or fifty feet. It has an average width of fifty, and a depth varying from twenty to thirty feet. The force which produced this separation operated with the greatest power at the east end, where the rock is broken and displaced, and the gap is from eighty to a hundred yards wide.

Other instances of fractures and of fissures occur in this rock, though none so large as those already given. From these facts, it seems that this rock has suffered more from agents calculated to produce these effects, than many others apparently equally exposed.

Fucoidal Layers.

Three miles from Chazy towards Lawrence's corners, near the highway, the fucoidal layers are remarkably well characterized. The rock is a bluish shale, intermixed with some quartz; but the materials were soft and fine, and hence the vegetables appear clearly defined, though too much enveloped in what must have been a *mud*, to show their specific marks. The mass is ten feet thick, and is a complete *matting* of fucoids. From this mass of vegetables there is a sudden passage to one filled with encrinal remains, together with Strophomena and Orthis. As this was not observed at any other locality in Clinton, I am unable to determine whether it is more than a local arrangement; and as the fucoidal mass is not sufficiently elevated to disclose what is beneath, I am unable to satisfy myself of their true position. About half a mile west, on a small stream, they appear in their usual form, passing into the potsdam sandstone below. No fossil is ever associated in these masses of fucoids; they seem to have excluded every thing else, and to have formed a surface not well adapted to the habits of marine animals.

Calciferous Sandrock.

This is composed of

1. A mixture of calcareous and siliceous particles, forming a rock of a yellowish brown color, in which calcareous spar forms a constituent part. It is always granular. It is too earthy to receive a polish. A few fossils make their appearance in the upper part of this mass.

2. Dark-colored mass, filled, in the upper part especially, with broken encrinites and corallines; besides which, there are numerous individuals belonging to the genus Strophomena.
3. Strata of tolerably pure limestone, filled with bivalves, most of which consist of the Orthis. Ten feet thick.
4. Strata of corallines and broken encrinites, with a reddish hue. Four feet thick.
5. A mass quite dark-colored and finely granular, partaking lithologically of the calciferous sandrock. It is filled with univalves, among which is the Euomphalus, Bellerophon and a new undescribed fossil, the *Scalites angulatus.* Twenty feet thick.
6. Strata composed almost wholly of the Orthis, and probably the species referred to in the third paragraph. Twelve feet thick.
7. Repetition of the broken encrinites and corallines, the fragments of which are red. The thickness of this mass could not be determined, as it passed beneath the soil.

In drawing up the brief view of the calciferous sandrock in Clinton, I have had in my mind a locality about three-fourths of a mile southwest of Chazy village. All these masses are revealed by an uplift, in which the exposure is remarkably good. The entire thickness of this rock in Chazy, or even in Clinton county, cannot be determined by any exposure of it which has yet fallen under my notice. At the locality cited above, the lower part is concealed, while the upper is remarkably developed. Throughout the whole, as it is here exposed, it preserves certain mineralogical characters which belong to the rock; a mixture of yellowish or brownish earthy matter, to which it owes its dull earthy lustre.

The most interesting phenomena connected with these masses, are the great abundance of fossils in rocks so ancient; and while this is a fact, another equally if not more interesting, is the limited number of species, and the immense number of individuals — so much so, that entire strata are made up of them. This, however, coincides with what has been brought to light in other places, both in Europe and America: it being established that species are less numerous in the lower than in the upper rocks, but a compensation is made by an increase of the individuals of the species then living.

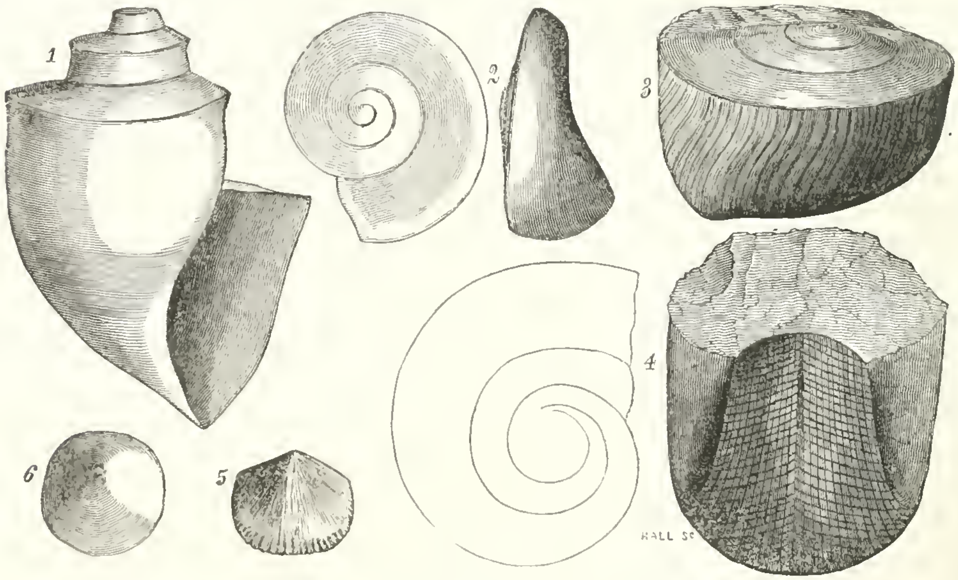
When my attention was first directed to the fossiliferous rocks of Clinton county, I was disposed to adopt the opinion that the great development was strictly confined to Chazy and its neighborhood; and although I do not find, in my examination, any other masses so full, still many localities furnish a part of the same members which belong to the Clinton rocks; and it is a curious fact, that while one of the members of this series is largely developed as the encrinal beds, we find a sprinkling of the same fossils, the stomachical plates of an encrinite, in the Mohawk valley, the whole mass being only one or two inches thick. But in relation to extension, it will probably be found that the lower rocks are by no means limited. When the characteristic fossils are more generally known, and the attention of geologists is turned to the lower rocks, they will be found to be widely extended.

The fossils of these lower masses are mostly new species; and among them there are probably two or three new genera, which number will perhaps be increased by farther examination. But whether new or old, it is satisfactory to discover the same general forms, the

same orders, and animals adapted to the same state and conditions generally, as in subsequent periods, and even as now prevail.

The most common genera of the calciferous sandrock are Orthis and Strophomena, both being abundant among the lower layers. They are the genera which figure so largely in the oldest fossiliferous system, running up to the old redsandstone. Some of the common fossils are given in the annexed figure; and though among the oldest inhabitants of the globe, they resemble some of the common species of our own period; and should they be presented to any palæontologist ignorant of the position which they occupy, he would place them in or above the carboniferous system. We find, therefore, that general form and modern look cannot be trusted in deciding the age or era of fossils. In these older rocks, I have little doubt but a careful search will bring out a much greater number of species; and this I am warranted in saying, from the presence of many fragments of fossil bodies with those which are already discovered.

84.



1. Scalites angulatus. 2. Maclurea labiatus. 3. Maclurea striatus. 4. Bellerophon sulcatinus. 5. Orthis (n. s.) 6. Orbicula (n. s.)

The strata forming the calciferous sandrock at Chazy possess each a few characters worthy of a moment's attention. The first and lowest stratum furnishes the usual characters of this rock in other places, namely, the same mixture of siliceous, calcareous and other earthy materials, interspersed with distinct sparry masses: these are among the most constant characters which the rock reveals. Where the fossils begin to appear, they are small and obscure;

yet careful examination shows that they are numerous, but the rock is poorly constructed to yield them in a good state without mutilation.

The second mass is probably twenty feet thick, and is composed almost entirely of the broken columns and disjointed stomachical plates of apparently a single species of encrinite. Of the columns, scarcely more than two rings remain attached : they are mostly single. The colour of the mass is such as to conceal, from common inspection, the great number which enter into its composition.

The third mass is made up of multitudes of the genus Orthis. Its general color is grey, and it contains less of the dull earthy matter than the lowest mass. It is ten feet thick.

In the fourth mass, we are again furnished with the same species of encrinite, and in the same broken state. The principal difference is, that many of the fragments have a peculiar reddish tinge ; and what is particularly interesting in this, as well as the other strata possessing the same organic character, is that they resemble a mass much higher in the series. I have in view the encrinal rock at Lockport ; and though the species are not the same, yet the masses would be confounded together without a particular examination.

In the fifth place, we come to those strata where the lithological characters of the calciferous are again clearly renewed. The color is darker than usual, but still we have the same materials and the same arrangement, except that there is less of crystalline matter, and it is rather more siliceous. This mass is not so well separated into layers as the preceding, and it is difficult to break it so as to secure a favorable presentation of its fossils ; and hence I have been obliged to rely principally upon the weathering of the mass, to obtain them. These strata contain the univalves, and two of them appear to be new species. In addition to these, however, I found a new species of Isotelus and of Illænus, but neither in a perfect state : the ends only could be procured, and these in a separate state. The thickness of this mass is not far from twenty feet.

The next or sixth mass, we find to be a repetition of the *Orthis stratum ;* but it contains a still greater number of this fossil, than the preceding mass does. I have not been able to find characters sufficiently important to distinguish the Orthis of this mass specifically from that of the mass below.

In the seventh place, the encrinal mass appears again : its characters differ but little from those below. The pieces of the encrinite are generally red, and there is less earthy matter ; and when it is polished, it forms a handsome marble. In all the encrinal masses, I sought in vain for heads, and parts which adhered together. Interspersed with these fragments are numerous but small oval bodies, pitted all over like a lady's thimble. These pits or pores extend into the coralline, but superficially. They resemble the pores of the fossil described by Mr. Conrad, under the name of *Fucoides demissus.*

The preceding strata, I ought now to remark, do not embrace all which belong to the calciferous in Clinton, nor even in Chazy. We find a large development of drab-colored homogeneous strata at several places ; one in particular is two miles southeast of the village, where attempts were formerly made to convert the rock into lime. At this place it is light yellowish brown, the effect of weathering, which penetrates it one-half or three-fourths of an inch, the interior

of the stone being a bluish grey. This mass has a compact structure, and breaks in conchoidal surfaces; and from its appearance, I consider it a good hydraulic limestone. In weathering, it softens and disintegrates, and forms a yellowish earthy substance.

Another variety of hydraulic lime is in the same field with the preceding; its color is bluish black; it breaks with a conchoidal fracture, and thus resembles the black hornstone. This mass is only four feet thick, and is interesting principally as adding to the varieties of this rock, which have been already shown to be great.

In Chazy, those strata which are drab-colored never contain fossils; but at Glen's-Falls, the strata equivalent to these contain fucoids, but they lie between the layers, and do not penetrate the interior.

As the drab-colored layers of the calciferous sandrock of Eaton never contain bivalve or univalve shells, it is highly probable that the combination, or the materials forming the mass, contained substances which were injurious to animal life; or it may be possible that they were formed of thick muddy matter — matter which accumulated rapidly, forming in consequence a bottom unfavorable to their habits and wants. Both causes may operate: the muddy mass itself may contain decomposed pyrites, or some other metallic salt, and the mass may be only a few days in forming.

Range and extent of the Calciferous sandrock.

I have taken my type of the calciferous from the exhibition of this rock at Chazy. Such will probably be found to be its prevailing character in Clinton. Such appears to be the fact, from indications wherever we have an opportunity to examine it. Much of the surface, however, is covered with debris, and hence the opportunities for obtaining a full and correct knowledge of this rock are wanting. Commencing south near Unionville in Peru, upon the Little Ausable, some ten miles west of Lake Champlain, I found the calciferous outcropping here upon a line running nearly north. This brings its western edge a little west of Peru village; and following this direction, with the assistance of its occasional appearance, I find it four or five miles west of Plattsburgh. At about the same distance west, it runs to Chazy, near Lawrence corners, where the drab-colored layers outcrop. With some interruption, it pursues its course towards Chazy village, appearing about half a mile west; though immediately west, it is only eighty rods to the eastern outcrop of the potsdam sandstone. We find it therefore verging towards the east; and hence we find that in Champlain, the adjoining town, it has approached the lake full three miles. Some of the strata belonging to this rock, in fact, appear upon the lake, though we still find outcropping masses two miles towards the village of Champlain. The line of junction between the potsdam and calciferous is no where distinctly seen. I was able often to limit this doubtful point down to thirty or forty yards; but the debris, which is thick, has always prevented a full disclosure of the whole mass of the superior rock.

The western outcrop of the calciferous sandrock may then be considered as about ten miles west of Lake Champlain, in the south part of Clinton, and as running a north-northeast course,

when it actually reaches the lake near the Provincial line. The potsdam sandstone prevails immediately west of this outcropping edge. But I do not intend to convey the impression that this outcrop still pursues this north-northeast course: it has its limit here; for I find that according to the known geological structure of the northern slope into Canada, this line of outcrop sweeps around to the west; and upon this there is the same succession of rocks, in advancing north again, as we have upon and adjacent to the shore of Lake Champlain. For example, nine miles south or southwest of St. Johns, the identical encrinal masses of the chazy rocks crop out, and are quarried for building stone. The fact, too, is brought out by the dip of the potsdam in Mooers and Ellenburgh; and from these lower masses the formation or group runs up to the loraine shales, which are fully formed at Laprairie, and are geologically the highest masses on the river south of Quebec.

I have now defined the western outcrop of the calciferous in Clinton county; and as the dip of the rocks is generally easterly, or rather northeasterly, we shall have a belt of this rock parallel with that of the potsdam sandstone. It is, however, narrow: at Chazy, it is only eighty rods wide; and it probably will not average a mile in width from Unionville to Champlain, the whole length of the county.

From the preceding observations, it will appear that the calciferous sandrock in Clinton presents the same general characters as elsewhere. There are wanting, however, one or two varieties which are found at other places; for instance, the cherty mass, and that which abounds in geodes of crystals. Both of them are found at Whitehall, and also at Essex, though at the latter place it is not largely developed. The difference, however, between this rock in Clinton, and as it exists in the Mohawk valley, is, that in the former a greater proportion of calcareous matter enters into its formation, and in the latter, silex predominates. Still the same general characters, as remarked above, appear in each region; there is not, in either case, so great a disproportion as to give the masses aspects which are specifically different.

Chazy Limestone.

The chazy limestone, in the ascending order, succeeds the calciferous, which, as I shall be able to show, has been separated from the preceding for substantial reasons.

It is a dark-colored, thick-bedded limestone, and as it formed at Chazy, is quite rough and irregular in its exterior. Its planes of bedding are very indistinctly defined and uneven, and hence never separating in smooth surfaces. Its general structure appears concretionary, but ill defined. Chert or hornstone is often diffused through it, particularly in those places where fossils occur, many of which are siliceous casts.

The characters above given are not absolutely uniform; as at Westport in Essex, it is a tolerably even-bedded rock, and though not free from siliceous matter, still it may be quarried and employed for many purposes, being susceptible of even and handsome surfaces. But at Chazy, the greater part is too irregular and uneven, and too much filled with nodular masses containing chert, to be employed economically. The best exhibition of the rock is only a few rods west of the village, where it forms several important ridges running nearly north and south.

I find it important to notice still further some diversities in the chazy limestone, as we may find them in the ridges here referred to.

1. Besides the concretionary masses, there is quite a thick bed of grey oolite; the concretions are quite small and uniform in size, not exceeding a pin's head. It is clearly within the limits of this rock, as we find several feet of the black irregular-bedded limestone, containing the maclurea, which has already been described as one of the characteristic fossils.
2. Next above the oolite, are several feet of broken encrinital columns, apparently of the same species as those below.
3. A hard dark-colored mass follows, containing orthoceratites and maclurea. This is only six feet thick.
4. Twenty feet above the latter, there is a mass of shaly limestone not less than fifteen feet thick, which retains also the fossils of this rock.

To these strata succeeds a drab-colored mass, which probably belongs to the birdseye.

The fossils of the chazy limestone have been in part enumerated. The Maclurea is the most abundant, and probably there are several species. Some individuals attain quite a large size: a fragment of one in the State Collection is seven inches in diameter, and is nearly three inches thick through the centre. This fossil has the general character of the Euomphalus. A much smaller species is common at Chazy, in which the thickness is in a greater proportion to the disc; it is only about one inch over the flat disc, while its greatest thickness (which is at the mouth, and hence marginal) is half an inch.

In the mass immediately above the oolite, numerous orbiculæ appear. These are quite deep, or rather conical, and we find only the convex valve. This is the lowest situation in which this genus has yet been discovered: and it is a curious fact, though an analogous one has been stated, that it is a recent genus, and has survived all the changes from this early period down to the present, and probably the number of genera which have survived will yet be increased. There are no inducements for deceiving ourselves in this matter. the great lapse of time does not militate against the existence of genera, though we may conceive it would against that of species; neither does the long continuance of a genus shorten, in our mind, the days of the earth's age. So far, however, as observation extends, the long-lived genera are confined to small testacea.

A remark which may not be inappropriate here, is important to be borne in mind, viz. that the lithological characters of a rock control, to a certain extent, the organic forms, without regard to position; and I adduce in support of it, the fact that most of the forms in the calciferous and the lowest limestones, are those found in the trenton limestone. The Isotelus canalis resembles the I. gigas; and so also with the bivalves, so far as they go, the Orthis and Leptæna in particular. But an illustration of this observation may be had when we compare the loraine shales with those in the Hamilton group. Many of the forms in the former appear at first view but repetitions of those in the latter. The cypricardites, for example, in each rock, are remarkable for their close resemblances to each other, although they are so distant in time. This fact, however, is one for which we may give a satisfactory rationale. It is only in the general form that this similarity is found: the species are clearly distinct.

The chazy limestone at Chazy is about one hundred and thirty feet thick, but probably it is in much greater force here than at any other point along the Champlain. It is proper to

add, however, that some of the beds which I now place in this rock, namely, the oolite and the encrinal mass, amounting in all to some twenty feet, were not included in this estimate. It was not until after my return from the field, that I saw the necessity of placing these strata in the chazy rock.

The thickness of the chazy limestone can nowhere be so well determined as at the locality I have described, though it appears at numerous points. In determining its limits, I have been governed by the presence of the Maclurea, a fossil which certainly has never been found in the trenton limestone above, nor in the calciferous sandrock below; but whether it is ever found in the birdseye, I am not so certain, and farther observations are required to set the question at rest.

I have described this rock as one which, for economical purposes, will not appear important. This is true of a large portion of it, as it exists at Chazy. There are, however, some strata even there, whose regularity and freedom from cherty matter will place it among the useful rocks. When even-bedded, or when a tolerably pure limestone and without concretions, it is very much employed for jambs, or the less important parts of a fireplace. When sawed, a very large proportion of the slabs present a surface marked with arborescent forms, which are probably fucoids. The surfaces, too, on weathering, exhibit in relief the same appearances. All are, however, too much without character, to entitle them to a particular description; and it is not certain that they are vegetables, as in pasty masses, when two or three materials enter into a composition, there is a strong tendency for one or more to separate and assume this arborescent form.

In the use of this material for jambs, etc, it has an important property not possessed by the fine black marbles, viz. strength; and hence it is suitable for all those parts which are to sustain much weight.

This rock, I may remark also, might sometimes be employed as a cheap black marble, when it is not so hard as to occupy too much time in giving it a finished polish. There is usually, however, too much grey in the polished face to form an ornamental material, and the general appearance is somewhat muddy. Specimens, both polished and unpolished, are placed in the State Collection. The flinty or cherty particles in this rock at Chazy are always found mineralizing a species of Columnaria: the columns are smaller than in the one which is figured in page 276, but they are so much distorted that the species cannot be determined.

Birdseye Limestone.

Three varieties of this rock were noticed in Chazy: a dark and a light variety with drab-colored layers intervening. The two first break with the usual brittleness and conchoidal fracture; the latter is tough, and somewhat siliceous. The fossil common to this rock (*Fucoides demissus* of Conrad), is replaced wholly by calcareous spar; in consequence of which, organic traces are entirely obliterated. All of the mass which breaks with a conchoidal fracture, is a pure carbonate of lime: it is entirely free from visible particles of uncrystallized earthy matter.

This rock alternates here with a series of strata, which I have not elsewhere observed. They incline to the yellowish brown colors of the calciferous, and take in silex largely. The whole thickness is at least fifty feet, and there is a great diversity among the layers themselves. A mass about fifteen feet thick contains innumerable individuals of a species of Atrypa, which, so far as observation has proved, is the lowest position of this genus. Above all these diverse layers, the birdseye again appears in its usual form, with a thickness of about fifteen feet, when it is succeeded by the trenton limestone. This is the arrangement at Chazy village, and the strata intervening between the two beds of birdseye are all laid bare by the Little Chazy river, which flows over them.

Some localities of this rock near Chazy, furnish layers which may answer for marble. It is a sound rock, and perfectly free from fractures or shakes; and where light colors are preferred, this would probably be esteemed.

This rock, in common with the black marble of Isle La Motte, polishes, and, when properly managed, receives a high lustre; and as it is a pure carbonate of lime, free from earthy matter, or silex, it polishes and works with ease.

This rock weathers only to a slight depth, the outside becoming lighter colored — an ash; but it appears like a mere film upon the surface. It does not possess the strength of the trenton or calciferous, but breaks like flint with a slight smart blow. This is an objection to its employment for some purposes.

This rock is one of the most valuable in this county for furnishing a pure quicklime. The Redford Glass Company use no other than is furnished from it at Chazy; and though the rock itself is dark colored, it burns white, and produces a pure lime.

Black Marble.

Between the birdseye and the trenton limestones, there is a mass of black marble, which I have already described under the name of *Black Marble of Isle La Motte*. This rock is not wholly confined, even in this section, to this small island. Bordering the shore at the steamboat landing at Chazy, this mass of black limestone is exposed; but as it has not been laid open either by artificial means, or naturally, it was impossible to arrive at its value. The fact of its existence is clear, and it seems to be exposed or laid bare by the removal of the trenton limestone.

The most important quarries of this mass are at the island opposite the landing, and probably half a mile distant. Upon the island are two quarries, one at the north, and the other at the south; and what is worthy of observation, is, that each extremity of the island is raised up, while a depression runs through the middle, which in some parts is below high water. This mass occupies the same geological position as the black marble at Glen's falls, already described; and though it is comparatively a thin mass, it still deserves a place in our system of rocks.

One of the most common fossils of this mass is a columnaria, which is very large and fine at Chazy. It is the same as that which is found in the Chazy limestone, though the birdseye

which intervenes, never contains it. Orthoceratites are sometimes large and abundant. Very few, if any, of the Trenton fossils are ever found in it; hence it seems to be a mass more nearly allied to the limestones below, than to those above.

Quarries of this marble might be opened at or near the landing at Chazy. The texture of this mass, if any thing, is finer than that upon the island, and might probably be worked to equal profit and advantage.

Trenton Limestone.

This rock, though well characterized in Clinton, abounds more in shaly layers than usual. It commences (taking the locality at Chazy as the type for description) with alternating layers of black limestone from two to four inches thick, and black shivery slate in almost the same proportion. The layers of limestone are somewhat thicker in a higher position; but, in general, such is the character of the whole mass, which is about four hundred feet thick at Chazy. Varying but little from the above, I found the same rock at and in the vicinity of Plattsburgh. The calcareous part is fine grained, and as beautiful as any of the black marbles, but it is very tough and difficult to break.

In all respects excepting the amount of shale, the trenton limestone of Clinton maintains a uniformity of character, and in all respects agrees with the same rock at Trenton and Glen's-Falls. The position it occupies geographically, is near the lake shore. At Chazy, it is farther west than at any other place from Whitehall to Champlain, and here it is only four miles. The probability is, that Lake Champlain now occupies the space which was once filled with this mass; and that, being slaty and subject to disintegration, this rock has in a great measure been broken down and decomposed. On either side it remains, and also in the islands it forms the surface rock; but the great mass, for one hundred and twenty miles in length, has disappeared.

At Plattsburgh upon the shore of the lake, and at Cumberland head and the shores down to Rouse's point, the trenton limestone is the surface rock. The upper part of the mass at Isle La Motte is also the same; and we find it overlying the black marble, so justly celebrated for mantel and other ornamental purposes.

The fossils, wherever they occur, are similar to those at Trenton, as the Isotelus gigas, Calymene senaria, Orthis alternata, etc.; each of which abound at Plattsburgh and Chazy, Cumberland head, Grand Isle and Isle La Motte. For figures, see Jefferson county.

The extent of this rock may be learned from the preceding localities, and the remarks already made.

Utica Slate.

This rock forms only a narrow belt in Clinton, and is confined wholly to the immediate vicinity of the lake: its exposures, too, are quite limited and unimportant. The only position in which it can be examined, is three or four miles southeast of Chazy, towards the lake. It presents nothing of sufficient interest to require even a passing notice. On Grand Isle, or

the South Hero, it forms the cliffs upon the southeast side, opposite Milton in Vermont. We have, therefore, a few opportunities for an examination of this mass in a state and condition free from the Hudson river shales. Usually it is so much enveloped in the latter masses, that it is difficult to form a judgment of its characters, particularly when in the midst of the disturbed strata.

Dip and Strike of the Rocks in Clinton.

As the rocks repose upon the eastern slope of the primary, their general inclination is eastward. It is not, however, unfrequent to find it northeast, or veering round towards the north. A few examples of dip, will be sufficient to convey to the reader all that is necessary upon these points.

About four miles south of Chazy, the calciferous sandrock dips nearly east. At the village, in the bed of the creek, the rocks or strata associated with the birdseye dip N. 60° E.; the amount is 20° to 25°; the strike or trend, N. 60° W., and N. 60° E. Following the masses in the ascending order some twenty yards, the dip is still more towards the north. If, however, we examine the dip of the rocks at the uplift about half a mile southwest of the village, and pass over the several uplifts in the direction of their dip, our course will be southeast. But if we commence an examination a little to the north of the locality just cited, we shall find the same rocks dipping to the northeast, or considerably north of east. We find, therefore, in the same masses, and those also proceeding almost from the same point, a divergent dip; a fact, which I do not remember to have fallen under my notice before. Pursuing the dip in either direction to the southeast or northeast, it becomes less, until it amounts to only a few degrees.

The principal force producing an uplift of the rocks I have been describing, operated upon the lower portion of the calciferous sandrock; and hence the succeeding rocks are but little altered from their original horizontal position two or three miles to the east, diminishing gradually towards the higher masses, or towards the southeast and northeast. In all the rocks of Clinton, the dip has rarely suffered a local derangement. The forces usually concerned in overturning and deranging the strata, appear to have been quiescent over the whole of this county. Near the locality of the fucoidal layers, the calciferous is slightly dome-shaped, being elevated or pushed slightly upwards, so as to give a gentle dip in all directions.

As a field for study, Clinton county furnishes some useful and interesting phenomena, particularly in the succession of masses from the potsdam and upwards, to the utica slate; and what is well worthy of particular note, is the distribution of the fossils, they being confined to masses with as distinct limitations as any geologist can wish. Even few strata of the calciferous contain fossils limited to them exclusively, and appearing neither above nor below. I state this rather as an illustration to the student in geology, of the mode in which fossils are distributed, and of the characteristics which they furnish for identifying distant rocks, and sometimes strata.

The rocks of these lower masses, it has been said, are abundant in fossil individuals of a few species; and it is a remarkable fact in palæontology, that they are confined to such narrow

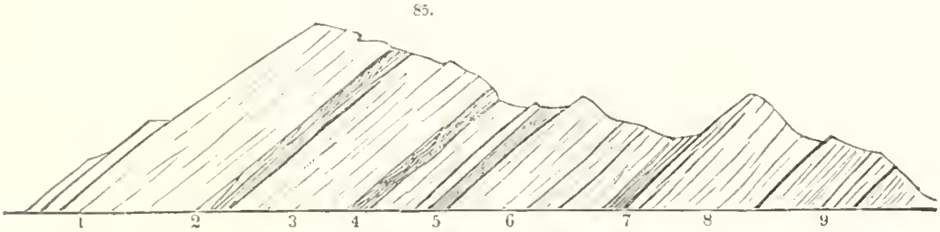
limits. Not one of the species of the calciferous is found in the trenton limestone, and I have never observed any in the birdseye of the Mohawk; but it seems to limit these particular species too much, to suppose they have in no instance reached the beds which succeed so soon, and which differ so little in composition. It is certainly remarkable that nature should restrict the existence of several species to the bounds of ten feet, and sometimes less.

Section of the Champlain Group, at Highgate, Vt.

The shore of the lake upon the east side has been already spoken of as consisting of the limestones, shales and grits of the upper members of the Champlain group. The red and grey grits, which were described under the head of Essex county as ranging in a northerly direction through Addison and Charlotte, appear again south of Burlington on the lake shore; also at Sharpshins, north two or three miles, where it lines for a great distance the shores of the deep bays which abound in this part of the lake. These red and grey grits have been described in sufficient detail, and their general range and geological position clearly pointed out. The mass of shales beneath, however, may well receive a moment's attention; as no opportunity has yet offered for describing these remarkable masses, so as to present them in all their phases. I shall not, however, go into a minute description of them, but confine my remarks to one or two localities where they are exposed to inspection by uplifts.

One of these localities is Highgate, situated on both sides of the Missisque river, where there is a considerable fall, partly in consequence of the disturbance of the rocks, and partly from their perishable nature, being worn through by the action of the current in the river, which is exceeding powerful at this place. The following section exhibits some of the strata, which are broken through at this place:

85.



1. Masses of shale and grit, alternating regularly with each other.
2. Fragmentary limestone.
3. Slaty limestone.
4. Dove-colored limestone, which appears to be equivalent to the Swanton marble.
5. Even-bedded slate.
6. Dove-colored limestone, with a few fossils.
7. Drab-colored layers, similar to strata in the calciferous sandrock.
8. Slate filled with imperfect concretions.
9. Drab-colored even-bedded layers.

Probably few formations present so great a diversity in lithological characters. In the space of fifty yards, all the varieties above enumerated are exposed in nearly perpendicular cliffs, from seventy to one hundred feet high. The dove-colored limestones are among some of the

remarkable strata here exposed. It is a pure limestone; the base is of a dove color, but traversed, or rather reticulated, with seams of calcareous spar. Its beds are very obscure, and it breaks into irregular angular fragments. At Swanton, it is quarried for marble.

Some other strata prevail here, which are interesting from their composition, being made up wholly of angular fragments, in which the stratification in each is preserved; generally they are oblong, or longer than wide, and some of them weigh from twenty-five to one hundred pounds. They lie in all directions in the stratum; for the mass, as a whole, is stratified. Annexed is a cut (fig. 86), representing the manner in which the fragments are arranged.

86.

Besides exhibiting the manner of arrangement, it shows also the mode in which some of these masses are traversed by veins of calcareous spar. Thus, the dark lines represent those veins which frequently cut through the fragments, and they prove very clearly that the cracks were formed in the mass subsequent to the recomposition of the stratum. It is quite difficult to conceive of the mode by which these strata were recomposed, and the whole stratified with so much regularity, at the same time that all the angles of the fragments are preserved as perfectly as they were when first broken; and it is equally difficult to explain how rocks were, in the first place, comminuted in the way we find them in these strata.

The Champlain group extends east of Highgate about six miles; and for this distance, it appears to consist of repetitions of the same masses, which are occasionally exposed in cliffs above the plains, by uplifts, and in many instances by the abrading action of running water in the more depressed portions of this section of country.

At Sheldon, we leave the Champlain group, and pass directly to the Taconic system; consisting, at its extreme north in Vermont, of the same masses of slate and limestone, as in the counties of Columbia and Dutchess in New-York.

Taking a general view of the rocks upon the east side of Lake Champlain, and those in the same range both north and south, we find them consisting of the upper members of the Champlain group. To the east succeeds the Taconic system, whose width is from six to twelve miles, made up of the same members which compose it in Berkshire county, Massachusetts, with the exception of the granular quartz. This general arrangement extends at least to the latitude of Quebec, presenting one of the longest formations yet known to geologists.

TERTIARY BEDS OF CLINTON.

Very little information can be gleaned in this county, in relation to the fossiliferous beds of the tertiary. I am able to state only one or two facts.

The upper beds of the tertiary are wholly wanting: at least they do not appear in place. Upon the lake shore, the clays belong to the lowest part of the mass; and there being no where,

that I could observe, any points to protect these soft materials from washing, they all appear to have been carried south, where we find in and about many places, as Keeseville for instance, great depths or beds of sand. Upon the highest land near the lake, I found shells more or less comminuted — some, however, nearly entire; but from appearances, they and the sand, in which they are found, appear to be drift. The place referred to, is between Champlain village and the lake towards Rouse's point, and is about three hundred feet above the present level of the lake. I found, besides, many other places where shells appear to have lodged. In all these places, the accompanying phenomena are different from what they are at Port Kent and other places on the lake. The shells are mixed with small rounded masses of bluish limestone, and are quite broken. These facts, together with other circumstances, have led me to believe that they have been transported from their original beds to the places where we now find them.

Peat.

An important bed of peat exists in Champlain. It is one or two miles long, and about half a mile wide, and its average depth is not far from twelve to fifteen feet. Probably many others of less extent exist in the county, particularly on the western border. This, however, is very favorably situated for improvement; and should the agriculturalists be disposed to employ this material in farming, its value will become obvious at once. One of the richest and most stimulating substances may be formed of a mixture of dry fine peat, lime and animal excretions. This compound, if properly formed, may be used after the manner of plaster, and in a quantity not much greater; and while its fertilizing powers are far greater than plaster, it has not its disadvantage, that of exhausting the soil.

Drift, Superficial Covering, &c.

The superficial coverings of Clinton county are deep and important. Gravel, sand, and rounded masses of quartz four or five inches in diameter, are spread profusely over most of the county. For example, from Plattsburgh to Redford, a distance of twenty miles, sand, gravel and these rounded stones prevail the whole distance. The latter make their appearance about ten miles west of Plattsburgh, entirely filling the soil. But a more interesting distribution of gravel and rounded stone is found in the long ridges which traverse this county from north to south. These ridges mark the former bounds of the lake, or some other body of water; being evidently formed by the washing up of the gravel by waves. They are in some places thirty feet high, sloping on the east and west sides at a moderate angle. There are probably three or four of these ridges, for I discovered as many at different heights above the lake; but as I did not trace them far longitudinally, I am not able to speak with confidence of their number. That ridges are formed as has been stated, there is no doubt; and this fact proves conclusively the action of water upon these loose materials at no very remote period. And should the conjecture prove true, that more than one ridge has been formed, it will establish the position that there has been a gradual rise of the country adjacent to the lake,

or that it has at different times had its shores along several successive lines. One of the ridges runs about six miles west of Plattsburgh, and about north twenty degrees east, or nearly parallel with the lake shore. The military road from Plattsburg west, runs in some instances upon one of these ridges.

Ridges formed by waves may be always distinguished from those by other causes, by their sloping in both directions to and from the body of water which throws them up ; and the slope upon the land side will be steeper usually than upon the water side, which is another character quite distinctive of their origin.

I do not propose pursuing the subject of drift, gravel, etc., farther at this time. I deem it sufficient to point out a few leading facts, leaving it to others to trace out this ancient coast line, and deduce those inferences which they may find warranted by all the facts which can be obtained from the study of present phenomena.

Recapitulation of a few leading Facts in the Geology of Clinton County.

1. The primary rocks lie along the southern and western borders of the county, adjacent to Essex and Franklin, and consist of granite and gneiss.

2. The iron ores are in veins, some of which are in a state of peroxidation.

3. The surface rocks which predominate are the sedimentary, belonging to the lower part of the New-York system.

4. The greatest developments are confined to the lower limestones, the calciferous sandrock, chazy limestone and birdseye ; each of which is characterized by several new fossils.

5. The fossils of these masses belong mostly to known genera ; and those which appear to be new, belong to forms well known to geologists, and have a very striking resemblance to some of the most recent shells.

6. Drift is spread over a very large proportion of Clinton, occupying more particularly the central part of the county.

7. The most interesting fact presented by the phenomena of the loose materials, supports the doctrine that the country was elevated from a submersion, by several successive uplifts.

8. The upper beds of tertiary are removed ; and some of the remains are now found, with other drift, three hundred feet above the level of Lake Champlain.

FRANKLIN COUNTY.

The great length of Franklin county, and its situation as it regards water communication, are somewhat peculiar. It only touches upon one of the great outlets of trade and commerce, the St. Lawrence river, on its northwest angle.

Contrasting or comparing the general geological features of Franklin with Clinton, I find that the former is, as it were, the counterpart of the latter. In Clinton there is a great preponderance of sedimentary rocks, while in Franklin the primary are by far the most predominant ones. Extending south to the vicinity of Long lake, I find there is an uninterrupted range of the primary system for more than fifty miles, while the sedimentary rocks occupy a length north and south of about ten miles only.

The southern part of Franklin is known to be mountainous and broken, and to partake of the same general characters which have been described as existing in the adjacent parts of Essex. The most lofty of these elevations is Mount Seward. It is situated in the township of Tipperary, at the southeast corner of the county. Its elevation is supposed to be five thousand feet. As yet no one has succeeded in reaching the summit: the only attempt which was made during the survey, failed in consequence of the distance of the mountain from settlements.

The physical features of Franklin which arrest the attention more particularly, are the multitude of lakes which are sprinkled over the whole surface of the southern part of the county. Of these, the Saranac lakes are the largest and most important. They are, however, so generally known, that I deem it unnecessary to occupy time and space in the description. They belong to the largest class of lakes in the northern district; and like all the other clusters of lakes, they occupy that portion of the country which is near the summit level.

Primary Rocks.

The primary rocks of this county are, 1, Hypersthene; 2, Granite; and 3, Gneiss.

The former occupies the southeastern corner of the county, in the neighborhood of Mount Seward. Its boundaries I am not able to state with accuracy. The rock, however, is known to be limited to this part of the county.

Granite and gneiss form the surface rocks over the largest part of Franklin; and as they intermingle with each other, I deem it unnecessary to speak of them as separate and distinct masses, except in a few instances.

One of the extreme northern limits of the primary, is a prolongation of a few ridges of granite, which come up from the south, about three or four miles west of Malone. In Chateaugay, we find the primary extending farther north by some miles than in Malone.

The boundary of the primary, as it comes in from Clinton to Franklin in a northwest direction, runs a mile or two south of Chateaugay corners, and from thence southwest, or nearly

south, to a point four miles south of Malone, in the valley of the Salmon river. This boundary line then pursues again a northwest course, in order to sweep around those primary spurs which come up from Brandon, and which terminate a mile or two north of the road leading from Malone to Dickinson. The direction, after passing around these spurs, is southwest through Dickinson and Hopkinton, and then more westerly to Parishville. South of this line, the whole county is primary, consisting principally of granite, gneiss and hornblende.

According to these views of its topography as well as geology, Franklin lies west of the great chain of mountains which terminate at Port Kent; the succeeding range on the west being less elevated, and more broken into insulated mountains, as may be seen in its termination in the hills of Chateaugay, and those which lie to the south.

Iron Ores.

As in Clinton and Essex, so in Franklin county, the magnetic iron ores are found connected with the primary rocks, both with granite and gneiss. Having, however, described the phenomena of veins and masses of iron, as they exist in Essex and Clinton, very little need be said of the ores of this county, inasmuch as the facts do not vary or differ materially from those already given. A very brief account, therefore, will suffice to put the reader in possession of all that is material in the iron ores of this county. It is, however, but just to myself to say, that my object in giving so much detail and illustration of the veins and masses of ore in Essex and Clinton, was to furnish the miner, and persons directly interested in the iron business, with all the facts which were important to be known in order to pursue the business of mining, particularly on established principles, or under the guidance at least of correct observations; and as the veins are more abundant, and the circumstances for observation far better in those counties than in Franklin, it became necessary there to select those facts which appear to lie at the foundation of this business, and which are necessary to be known in order to secure success in its prosecution.

First, as it regards the geographical position of the iron ores of Franklin, it is evident they must be confined exclusively to the southern townships; and in order to be definite, I may say that they cannot be found in any of the towns in the two northern tiers, north of the boundary line which I have already marked out for the northern limit of the primary. I make this remark, in consequence of the claims which have been set up for mineral riches in the north part of Franklin. A more unfortunate claim could hardly have been made for any section of the State. The truth is, that almost all of the northern slope is sandstone, one of the most barren rocks known in mineral riches of any kind whatever. But in the great region south of the line or boundary referred to, the facts are quite different; for we find not only a possibility of the existence of iron, but a great degree of probability. The formation is such as extensive observation proves may abound in ores; though it is still to be remembered that no certainty exists of their presence, even when the geological structure is compatible.

The most southern point known to me of the existence of the magnetic oxide, is in the town of Franklin. At this place a vein of rather fine grained ore occupies a hill near the

falls of the Saranac, at Miller's settlement. The quality of the ore, so far as inspection alone can determine, is good; being free from pyrites, phosphate of lime, etc., and moreover rich in iron. Within half a mile of the vein, there is sufficient water power for moving the machinery of a forge or furnace; and withal the vein is situated in the midst of fuel necessary for reduction, sufficient for a long period of time. In this locality, I observed no fact not already stated, in illustrating the phenomena of veins of iron ore.

Another vein of ore, not far from this neighborhood, has been discovered on Chub river. Its appearance indicates an ore of like quality with that just described.

While at Miller's settlement, I was informed that a vein of black ore had been discovered near Tupper's lake. Of this I cannot speak with confidence, having never visited the place where it is said to have been found.

It is a fact worthy of remembrance, that it is rare to find a single insulated vein, or one that is entirely alone and unaccompanied with other veins. There seems to be in general a cluster of veins somewhat central to a main deposit; and hence, when one has been discovered in a section of country, it may, agreeably to experience and observation, be expected that more still exist in the vicinity. From the mode, however, in which many veins occur, it is a matter of chance whether they are discovered or not, as frequently they do not reach the surface.

Conger ore. There is a cluster of veins, apparently of some importance, in township No. 11, near the Port Kent and Hopkinton turnpike road, on lands owned by Mr. Conger. The Conger ore is black and coarse grained. On recent fracture, the lustre is bright. Some portions are fine grained, intermixed with decomposed feldspar. It contains also white flint, and some that is rusty brown. This ore, as well as the preceding, is in gneiss, in which hornblende, black mica, etc., form an essential part. So far as circumstances for reducing ore are concerned, they are favorable at Conger's, being in the midst of a wooded region, and in the vicinity of sufficient water power, near the great falls of the St. Regis.

In this same region, in township No. 8, three or four miles from Conger's, veins of magnetic oxide have been discovered, but they require farther examination before their characters can be fully determined.

Ores of Duane.

With the village of Duane as the centre, several veins are known to exist within a circuit of four or five miles.

Deer River ore. Lustre resinous and somewhat shining, but in parts dull. Breaks into angular fragments, the form and shape of which are determined by natural joints indicating cleavage planes, the surfaces of which are covered with a coating of green earth, or chloritic matter, which is not uncommon in ores of this description. The seams too are often incrusted with yellowish oxide of iron. Intermixed also with the ore, I observed some hypersthene. The vein is traversed longitudinally with seams of light-colored feldspar, especially by that portion containing hornblende. The faces of the hornblende have a glassy lustre. The gangue of the ore is principally hornblende, and coarsely crystalline, intermixed with large

imperfect garnets and some black mica. Hypersthene is mostly wanting in the rock. This vein is about three miles from the Deer river furnace, upon a hill one or two hundred feet above the valley of Deer river. This vein supplied, for a time, the ore used in the furnace at Duane. The castings made of this ore are of a superior quality, being very tough, and not liable to break : it is also easy to reduce in the furnace.

Deer river vein is about twenty feet wide, and it pursues a direction nearly east-northeast. It has regular walls, which are very well defined. The ore is clearly composed of a large proportion of the protoxide, being strongly magnetic, and sometimes possessing polarity. It has been traced seventy or eighty rods upon the surface, and furnished the strongest indications of a great amount of ore.

Another vein of magnetic oxide has been opened near the residence of Mr. James Duane. It is sufficiently rich for the furnace, and probably is one of the best for castings in this neighborhood. It is a wide vein, and the amount of ore inexhaustible ; and as it is situated upon a high eminence, it is favorable for mining.

Another vein, known in this neighborhood as the *Steel ore*, is found about four miles east of Duane furnace, upon a hill eighty rods south of the Port Kent and Hopkinton turnpike. The hill is a steep and abrupt rise of five or six hundred feet above the road. Like the preceding ores, that of this vein is a mixture of fine and coarse, but a larger proportion of the latter. It contains, too, more hypersthene than the Deer river ore, which may be distinguished in the ore by its bronze-like lustre. It is sometimes iridescent. Small particles of sulphuret of iron sometimes appear in it, but not in sufficient quantity to affect the reduced iron. It contains also small masses of feldspar, and crystals of garnet. The outside of the ore becomes yellowish brown by exposure, probably from the decomposition of pyrites. The recent fracture presents rather a high lustre, intermixed with surfaces which are dull. There is a tendency to crystallization ; the mass, as usual, breaking naturally into angular pieces. The vein pursues a northerly course, with a dip to the east. Its width is variable, being from a few inches to seven or eight feet. It is greatly disturbed by trap dykes, which are obstacles of some importance to an economical pursuit of the ore. The walls, as would be inferred, are broken and irregular. It is embraced in a rock composed principally of hornblende, with some quartz and feldspar.

I may remark here, that one of the differences which prevail in the rocks of Essex, Clinton and Franklin, is that the latter are supplied with a greater amount of hornblende and black mica ; a circumstance, however, which appears to be of little consequence, so far as the value of the ores are concerned. Sometimes they are more difficult to break.

A few remarks upon this ore, as it regards *its steel properties*, as they are termed, will be expected in this place. Besides having made a report upon this subject, and finding that I have been misunderstood by some, I deem it but right that I should in this place disabuse public opinion in relation to the true character and nature of the ore under consideration.

The ore, as has been remarked, is the common magnetic oxide, differing in no essential respect from the ordinary ores which are ranked under this name. It has no better title than any of the others to the designation of a *steel ore ;* that is, it contains in itself no element

which converts the ore, by its combination with the metal during its reduction. It is simply a compound of oxygen and iron in certain proportions. Now in order that common readers may understand what is necessary to make iron from an ore of this description, I remark, that all that is to be done is to discharge the oxygen. This is effected by the action of carbon, or rather charcoal, when the temperature of the ore is raised to a red heat. Heat alone is not sufficient: charcoal must be in contact with the ore; and then, under these circumstances, the oxygen leaves the iron, and combining with the coal, forms carbonic oxide and acid, and escapes in the form of gas or air. This change in a pure oxide, one that is composed solely of iron and one proportion of oxygen, is rapid, easy and perfect, and the iron is immediately obtained; or if the ore is composed of the peroxide of iron alone, the reduction is equally easy and certain.

The constitution, however, of this ore, as well as that of most magnetic oxides, is different: it is composed of iron, with the protoxide and deutoxide in combination. Now, what is the result, the unavoidable practical result, when ores of this description are put into the forge or furnace for reduction? It is this: The particles of the protoxide contained in the mass of ore will be first reduced; that is, the oxygen will sooner escape from this combination, than it will from the deutoxide, in consequence of the latter containing double the quantity of oxygen contained in the protoxide. When the reduction has proceeded thus far, only a part of the ore is ready for casting or hammering, and it is more or less mixed with unreduced ore; or that portion which was in a state of peroxidation, is only brought down to the state of a protoxide. Again, that portion of ore which has parted fully with its oxygen will not remain quiescent; and though it will not, under ordinary circumstances, reäbsorb oxygen, yet it will absorb carbon; and before that which is reduced to a protoxide has become iron by parting with its last atom of oxygen, the other will combine with a sufficient quantity of carbon to become what is called a *pot-metal;* and now, if it is attempted to hammer the mass, it generally falls to pieces. But the results will vary at different times; and it often happens, that in the forge, a mixture of steel and iron is made, which will draw out under the hammer. Such, I say, may be the result often, but more frequently it is not so favorable; and, according to my present views, I conceive it too difficult and uncertain a process to work the two oxides when combined as they usually are in the magnetic oxide.

The steel ore of Duane, when worked in the furnace and cast, forms a fine grained pot-metal of more than ordinary strength; and when cast into plane-irons, shears, and a variety of articles of this description, it answers a very good purpose. The combination of carbon in the case of the magnetic ores, is different from what it is in the scotch pig, or pig from the hematites. The latter, by no means, can be made into articles equal to those made from the magnetic ores. They immediately break, and fall to pieces by slight jars and blows, and are, as is well known, almost as unsuitable for sharp instruments as the oxides.

When the Duane steel ore is cast into chisels, plane-irons, knives, etc., it is possible to increase the hardness of the surface by heating, and then plunging into oil; and in this way, I have seen plane-irons in particular hardened and ground, which appeared as well, and per-

formed as well for a time as any ; and this I stated in a report to the Legislature. But it is a material which, after all, cannot be depended upon. Some of the smaller articles, as knives and forks, are elastic and finish well, and answer for a time ; but subsequently, after having been in use, they break unexpectedly by some slight jar or blow. Properly speaking, they do not *temper*. Hammers, springs, cold chisels, and all articles which require strength and elasticity, cannot be made by casting, in the mode which has been followed in the working of the Duane steel ore. That it may be an ore which is susceptible of conversion into steel, is highly probable ; and that it is a useful ore, when properly wrought, is not to be disputed.

The subject of working the compound ores in the forge, it seems to me, may now be pursued with success, if they are wrought according to the principles which are here set forth ; and according to these principles, the ore must be separated, and the protoxide must be used apart from the peroxide. This may be effected by means of the magnetic separating machine, referred to in the preceding pages ; but to attempt to reduce the ores when mixed, will not only be attended with trouble and uncertainty, but with a great and needless waste of ore and of fuel.

That steel may be made directly from the ore by one process, I have little doubt. For this purpose, take the magnetic oxide ; separate the protoxide from the deutoxide by the magnetic machine, after having reduced the ore to sufficient fineness by stampers ; then mix it with charcoal in a crucible, and raise it to a red heat ; continue this heat or temperature for twenty-five or thirty hours, or until the oxygen has disappeared, which may be known by the particles filing and giving the lustre of iron. When this is done, what is to hinder the iron already reduced from combining directly with the carbon with which it is mixed, and forming with it steel ? It is evident the process may be carried to any point which may be desired, and experiment will determine at what precise point the process should be stopped. In favor of this mode, I would say, that the iron is probably in the best state to enter into combination with carbon : it is porous, and its state and condition will be equal throughout ; the combination will be equal, and more rapid by far than when bars of iron are exposed, as they are close-grained, and are not in that mechanical state necessary to secure a uniform and rapid change from the state of pure iron to that of its carburet. Having formed the carburet, let it be melted and cast after the manner of cast steel. Now if the process is carefully conducted, and the proportion of carbon be right for forming steel, the cast mass may be hammered ; for by the first steps of the process, it is supposed that the silex and earthy materials are separated by the magnetic machine : if they are not, then there is no probability that it will hammer, or be found malleable.

In conclusion, however, I would remark, that probably better methods may be followed than the one pointed out ; and though no method directed to this end may succeed, yet I fully believe much more may be made of our rich magnetic and specular ores than has yet appeared.

Malone Ore.

About four miles west of Malone, several veins of magnetic oxide have been opened and wrought to a small extent. Three or four parallel veins occur, lying obliquely to the axis of a granitic ridge, each of which was pursued several rods. They are now abandoned in consequence of unsettled claims in relation to ownership. Being filled up, — no vein to be seen, — but little ore upon the surface, and that of an inferior character, it is impossible to give even an opinion either of the quality or quantity of the ore. Its position and relations are rather peculiar; and it appeared from the direction of the excavations, that the veins pursued a more westerly course than usual: besides the ore was mostly obtained loose with soil or hardpan, having been enclosed in a decomposing rock. The examination I made left the impression that those veins proceeded from another traversing the granitic ridge already referred to, and that those which have been opened are lateral or subordinate ones. This point, however, cannot be cleared up without a better exposure.

This locality is the most northern position which has been, or probably will be, discovered in the Second district: and it is almost the extreme limit of the Primary system. Some beds may be discovered near the junction of the potsdam sandstone and the primary, or in the same geological position as those of St. Lawrence and Jefferson counties. It is only, however, where the sandstone is thin and broken up, that there is any probability or prospect of finding the red oxide. The indications are found in the red color of the sandstone, its staining or soiling the fingers, and sometimes the exhibition of serpentine in the midst of the sandstone. There is, however, as will be seen, a very small prospect of discovering the peroxide. All the sandstone of Franklin is whiter and purer than usual, and more free from stains from the oxide of iron than in regions where it is known to exist.

Sandstone.

The Potsdam sandstone is well developed in this county. Fine and perfect examples of this rock occur at Malone and Chateaugay. From the northern boundary of the primary, the surface rock consists of this sandstone, extending beyond the Provincial line. The whole northern slope is composed of this rock. On the northwest, it passes beneath the calciferous sandrock. If a line is drawn from the northeast angle of Westville, southwest to Morristown, nearly straight, it will pass along the border of the two rocks, or their line of junction. In the towns, therefore, upon the northwest, the surface rock is a sandy limestone, passing into a tolerably pure limerock.

The potsdam sandstone extends frequently several miles up the valleys, beyond its general extension when the whole country is regarded; thus, on the Salmon river, it extends four or five miles south of Malone.

Some of the insulated beds of sandstone appear at the following places:

In Dickinson, the sandstone exists mostly in boulders, which are very numerous, epecially in the southern part of the town. In Bangor, one mile south of the church, there is a small

quarry, but it is upon the extreme southern edge of the sandstone. Four or five miles southwest of Malone, there is a fine mass of perfectly white sandstone. Three miles east of Chateaugay corners, on the banks of a creek, sandstone appears in fine even-bedded masses. Still farther east, in Ellenburgh in Clinton county, the sandstone forms continuous masses. It dips ten or fifteen degrees to the north. Upon this northern slope, both in Franklin and Clinton counties, this rock exists in thick heavy beds. Probably it is in greater force and thickness here than in any other part of the Second district. Thus at the gulf, or the deep chasm in this mass, we find it three hundred feet thick. There being no disturbance, and the rock only slightly dipping from the fissure, there is no danger of deception in regard to the thickness of the mass at this place. Some portions of this northern mass are much coarser, as a whole, than elsewhere. This fact, taken in connection with its development upon the northern slope, has led me to remark, that probably the source of the materials forming this rock was derived from the north. But the rock is very much concealed by an enormous quantity of drift which has lodged upon the northern slope, and hence it is impossible to ascertain the true extent of the sandstone.

In Franklin, this rock is generally whiter than in St. Lawrence, and less iron enters into its composition.

Moira and Bangor furnish fine quarries of this rock. It is thin, even-bedded, of a granular and sometimes a friable texture. It is not difficult to obtain slabs of large and perfectly even surfaces. It forms, therefore, not only a good flagging, but also, when the beds are of a suitable thickness, an excellent building material.

The banks of the Chateaugay, the Salmon and other rivers, present excellent quarries of this rock. Sometimes we may observe it upon the high grounds, but usually the rock is concealed beneath the gravel and sand, and hence it appears only where those materials have been removed.

Calciferous Sandrock.

This rock occupies the extreme northeast corner of Franklin. It is disclosed at Fort-Covington, in a few places near the village. Large boulders are abundant upon the surface, in which are geodes of pearl spar, crystallized quartz, and sulphate of barytes.

At Hogansburgh, upon the banks of the St. Regis, this rock is well exposed. The drab-colored layers are the strata principally in view for some distance upon the river.

So limited is the calciferous in this county, that the above brief notice is deemed sufficient. The series of sedimentary rocks extends no higher than this. The dip is northwest, at a small angle, and hence the succeeding rocks do not appear upon the east side of the St. Lawrence.

In the rocks just noticed, there are no disturbances by local uplifts, and we nowhere find dykes or other injected rocks. Hence the slight inclination of the beds, which was given at the time of the general uplift of the country; since which no disturbing forces appear to have modified, even locally, the rocks of which I have been speaking. Dipping as the lower

masses of the New-York system do to the northwest, we have every reason to believe that the succession continues, and that it is carried up at least as high upon the Canada side as the loraine shales.

In confirmation of this view, I may with propriety state, that at Bytown, the shales of Loraine or Hudson river form the surface rock. What the succession is in the intermediate country west of the St. Lawrence, I have been unable to determine.

In addition to the above, I offer merely the conjecture that the loraine shales are the highest rocks in this direction; that beyond them, the series runs down to the lower limestones, and finally to the potsdam sandstone. This last rock probably spreads out far to the west and northwest, being one of the most extensive of our sedimentary masses.

Drift and Surface Materials.

The northern slope of Franklin is covered with a thick mantle of sand, gravel and boulders intermixed. The boulders are composed of sandstone and granite or gneiss. The former are angular and slightly rounded, but the latter have their angles entirely obliterated, having been subjected for a longer time to the action of the elements. The sand is often disposed into ridges, but without regularity, either in their direction, or in their position with respect to each other. In Dickinson, for example, the south part is rough and uneven, and is covered in part with sand-hills, which are filled with boulders. Towards the north, the country slopes rapidly, and soon reaches the level of the St. Lawrence, where the sand is spread evenly, forming level and uninterrupted plains. Constable, Westville, Bombay, Moira, are all quite level, and present extended sand-plains. Malone, Chateaugay, Dickinson and Brandon, lie upon the descending side; and the loose materials are raised more or less in ridges, hills and banks.

In Covington, boulders of trenton limestone are quite numerous; the fences are made frequently of these travelled rocks; and it is a matter of some interest to ascertain where they came from. Among them are the two varieties of the trenton rock, the grey crystalline, and the black and nearly compact mass; each of them, when broken, exhale a strong bituminous odor. Having become well acquainted with these loose masses, I found, on a visit to Montreal, that the beds of trenton were identical with the boulders in Franklin, and particularly with those which I had previously seen at Hogansburgh; and I have little doubt but that these beds formed the parent rock, for all the boulders of limestone in this place have been brought either from Montreal or its neighborhood. The boulders of potsdam sandstone probably originated in the beds of this rock immediately below, as they have been extensively broken up, and left with their corners sharp; while those which have travelled far, have become smooth and rounded. The source of the granite cannot be determined with much certainty, only we know that it must have had its origin far to the north.

Soil.

The soil of the first and second tier of townships from the Provincial line, is probably as good as any in the State. Some parts, it is true, are sandy, but it is still susceptible of high cultivation, and yields abundant crops. The thermometer has, however, rather too wide a range for a very profitable farming country. The soil in the southern townships is not, generally at least, so good as that in the northern. In the vicinity of the Saranac lakes, the country is too damp, and the surface too much broken and filled with boulders to form an arable soil, and a very large proportion of the southern part of the county is in the same condition.

In addition to the boulders I have mentioned, those of *primary limestone* are found scattered over the surface in Duane. Their source has not been ascertained: but inasmuch as primary limestone is rarely found far from its parent bed, I infer that they must have their origin in the immediate vicinity. They contain fine purple scapolite, and green pyroxene in crystals; and what is quite rare, perfect six-sided tables of graphite.

Superficial Deposits.

Besides the ordinary drift of the country, a few beds of bog iron ore, tufa and peat, are known to exist, but in quite limited areas. At Westville, a bed of ore of this kind supplies two forge fires. The ore is continually increasing by deposition from water. Several other smaller beds are known also in this place. At Malone, bog ore is found at several places. But generally the deposits in this county are unimportant. Tufa is deposited largely from a spring in Chateaugay. The only fact worth attention is the source from whence the water obtains the calcareous matter, the whole country being primary, and destitute of limestone rocks. Peat is more or less abundant in the deep swamps in the interior and southern part of the county. The superficial deposits require merely this passing notice.

ST. LAWRENCE COUNTY.

St. Lawrence presents a complicated structure in its primary system; but in its sedimentary rocks, it is, like all the northern counties, extremely simple. In its topography or physical geography, there is a great uniformity; that is, we do not find any parts of it rising to great heights. All the higher lands attain but a moderate elevation, and a large proportion of the surface is but a few hundred feet above the level of the river St. Lawrence.

To give some brief details of its surface, I remark, that the two tiers of townships bordering the river are level. The rivers, when they have reached this part of the county, are sluggish, or have but a moderate current; and if they have falls, they amount to only a few feet. This space extends twenty miles east of the river, and a few miles farther in the northern part of the county.

The two next tiers of townships may be called hilly. The streams flow with greater rapidity. The remainder of the county, which lies to the southeast, embracing a district wholly unsettled, may be termed mountainous, though by no means extremely so. All the elevations are merely moderate, and fall far short of those in the western part of Essex. Through this region, the rivers flow not only with rapidity, but we find upon them many heavy falls; still, even here, some of them have long distances of still water and batteau navigation.

I do not propose to enter into farther details of topography. It is sufficient to state the general features, when there are no essential deviations from the ordinary levels of a country. We may regard the whole slope as facing the northwest; the southeast portion as being comparatively rapid; the middle portion as moderate; and the northwestern, or the two tiers of townships upon the river, as being quite moderate, or with only a sufficient descent to give a drainage to the country.

A feature of St. Lawrence, more striking in its character, arises from the number of large rivers which have their origin not far from the eastern border of the county. Rising in the wilds of Franklin and Hamilton, and partly in the adjacent part of St. Lawrence, they all flow first but a little north of west; but when they have reached the central part of the county, their course is nearly northwest, and after continuing a few miles in this direction, finally get around into a course parallel with the St. Lawrence river itself, in which course they traverse a large part of the county before they empty themselves into this mighty flood of waters. This disposition appears to have been produced by the change in the character of the rocks; the great change in the direction of the waters takes place near the junction of the primary with the transition rocks, and probably was occasioned partly by the denudations which have been effected in former times. We find, too, that the lakes near the St. Lawrence lie with their longer axis parallel with the course of this river, and their beds seem to have been channelled out by streams or currents of water which have flowed over this country in ancient times.

St. Lawrence county, though so well watered by living streams, has few lakes, in consequence of not extending as far east as the table land upon which they are so numerous. Black lake is the largest and most important; it is twenty miles long; and as Indian river empties into it, it may be made a medium of travel or navigation still farther. Its shores are low, and so far as scenery is concerned, it is not likely to be celebrated or praised.

The Great Geological Divisions of St. Lawrence.

For all useful purposes, and also for accuracy, it will only be necessary to divide this county into three principal regions: 1, The Primary region, comprehending hypersthene rock, granite, gneiss and primary limestone; 2, Sandstone region; and 3, Limestone region. The particular kind of sandstone and limestone will be stated in the proper place.

The first region or division comprehends more than one-half, but less than two-thirds, of the county. In general, I may say that all that part east of Canton is primary. But to be more precise in these boundaries, as they are few, and may be given with some degree of exactitude, I will commence at the extreme south, and proceed northeast. The primary extends over to the west side of Black lake, but only upon an average seventy or eighty rods, forming a narrow belt upon that side of the lake. It crosses two miles north of Depeyster, and runs nearly through the centre of the town towards Canton, running east two or three miles of the natural canal. From Canton, the line of junction between the primary and transition pursues an undulating course, running three or four miles east of Potsdam; the primary, however, appears at the village, thence to Parishville, and onward to Hopkinton. The line of junction, though it is described as pursuing generally a direct course, still it is more or less undulating the whole distance, varying on either side two or three miles. The course I have given, therefore, is what it purports to be; the general direction being sufficiently accurate and correct for all useful purposes.

I have now given the boundary line between the primary and potsdam sandstone. What remains is to make a similar line of demarkation between the latter and the limestone region, or that which is underlaid by the calciferous sandrock of Eaton.

Commencing as before at the extreme southern portion of the county, a few miles south of Morristown, the line runs nearly parallel with the St. Lawrence river, crossing the Oswegatchie four miles east of Ogdensburgh; it then diverges to the east, and adheres to that direction until it crosses the De Grasse river two miles east of Columbia, when it runs again about parallel with the St. Lawrence to Norfolk, whence it still pursues nearly the same direction to Brasher and Hogansburgh in Franklin county.

These lines of demarkation divide the county into three great regions in which the physical geography differs, and also into three distinct geological formations. They are unequal as to size, as has been remarked, but still we may consider the county as divided into three zones or belts; the eastern, central, and western. All of the first is entirely primary; all of the central, potsdam sandstone; and all of the western, which lies along the St. Lawrence, is composed of the calciferous sandrock of Eaton.

In the primary region, we find the rocks possess the greatest variety of character and complexity in the southern part. In the eastern, at Scriba, Bloomfield, Emilyville, Chamont, Sarahsburgh, Clifton, and other places, the rocks are more uniform, and contain less lime than in the region of Rossie, Gouverneur, Hammond, and others in the neighborhood.

The eastern border of the sandstone is broken, and usually thin. Some portions of it, as at Potsdam, are finely stratified, form a beautiful building material, and in fact are largely used for this purpose.

The calciferous sandrock is in many places nearly a pure limestone. The lower part, however, is not so fossiliferous as in Clinton; but at a few localities it furnishes a few fossils, and, as a whole, preserves throughout the character of this rock in other places. It exhibits at several places a large development of the drab-colored layers, which are used at Waddington for a water cement. It furnishes it in great abundance at Hogansburgh, Massena, Norfolk, and probably wherever this mass is well exposed. It is worthy of remark, that a very large proportion of surface is concealed by drift, both in the sandstone and calciferous regions.

OF THE INDIVIDUAL PRIMARY ROCKS.

Hypersthene Rock.

The existence of this mass in the extreme eastern part of this county, is well established. I saw boulders of it first high up the Oswegatchie, and afterwards in place in the vicinity of Cranberry lake. Of its extent and its relations, I am unable to speak with much confidence. At the time of my visit, I received the impression that it occurred under the same circumstances as in Essex; that it was connected with, or rather embraced, the iron ores of this region; and that it was, in fact, a prolongation or extension of the Essex mass. I have not, however, been able to confirm these impressions: no opportunity having occurred for visiting again this part of the wilderness of New-York. I shall not, therefore, attempt to give the extent or relations of this rock, being obliged to content myself with the bare mention of its existence in the part of the county already designated.

Granite.

At the commencement of this county, I remarked that the structure of St. Lawrence is complicated, so far as the Primary system is concerned. This condition arises from the frequent occurrence of two or three rocks within a small area, without regard to order or system, and also from the passage of the same rocks into each other. As an exemplification of this statement, the reader has only to peruse what was written in the first pages of this report upon the granite and limestone of this county, or to make a personal examination of these rocks in the field. He will find that granite often passes into limestone or gneiss, and *vice versa*, the limestone and gneiss pass into granite.

In its primary system, St. Lawrence is unlike the other counties. The proportion of primary rocks to the sedimentary does not differ materially from equality. All the towns occupying the northwest angle belong to the latter class, and all those of the opposite and southeast angle are primary. In the central portion of the county, on a line parallel with the St. Lawrence river, both classes are intermixed, and it is on this line that we find the most confusion and trouble in defining distinctly the outlines. The line of separation is extremely crooked and irregular; in fact, small patches of the sedimentary rocks are found far up on the primary, and cut off from any connection with the system to which they belong. And it is here that we find an area of a few square feet of the potsdam sandstone, three or four feet thick, remaining upon the primary; the whole bed, except this little patch, having been broken up and washed away, while this adhered obstinately to the mass below; but it has been almost obliterated, by the grinding of gravel and boulders which have passed over it. Owing to facts of this kind, I have not attempted to be exact in marking the divisions of the rocks, unless some fact of more than ordinary consequence rendered it important to establish for a limited space an accurate boundary line.

The granite of St. Lawrence possesses the following characters:

1. The reddish and grey granite at Alexandria, associated with ordinary gneiss and hornblende. It is the common granite of New-England; contains imperfect crystals of black tourmaline, and imperfect garnets.
2. A coarse grey or white granite, containing albite. It contains also perfect crystals of feldspar, pyroxene, smoky quartz, etc.; but it is better known as being always associated with primary limestone.

The first of these forms of granite, as just remarked, does not differ at all from the granite of New-England; and this statement holds good, not only so far as its composition is concerned, but also in the minerals which it contains; that is, if it contains any, they will be found without exception of the same kind and character.

The second variety is whiter than the former; is liable to decomposition and disintegration; and is coarse grained, often containing (besides large masses of feldspar, quartz, and plates of mica, which constitute the rock itself) imbedded crystals, sometimes arranged in veins, and at others without any order of this kind. This last variety may be said to occur in three modes, though I do not attach much importance to the distinction:

1. In large irregular beds, or protruding masses.
2. In the form of veins, branching irregularly into the adjacent rock.
3. In overlying masses, analogous to the overflowing of lava currents, or of greenstone.

The constant associate of these varieties is primary limestone; and as it regards superposition, the limestone is as constantly beneath, as the granite. In some places a mixture prevails, forming a perishable rock, but one in which may be found interesting mineral species.

Having given, in the early part of this report, a full account of this variety of granite and its associate, primary limestone, it seems to be unnecessary to repeat the facts again. I shall therefore only give those which are mostly additional, and which may have a local interest, and require a detail more minute than was given in the general account of these rocks.

Commencing at the southern tier of towns, a large extent of granite and gneiss is spread out, and forms the surface rock from Fowler southwest to Antwerp. The first two or three miles, this mass of primary is gneiss ; but as it passes south or southwest toward Antwerp, it becomes gradually a well characterized granite. This range is barren of interesting minerals ; and for the whole distance which it may be traced, it presents only a few imperfect crystals of black tourmaline and garnet. It is rather coarse, and appears to be intermediate in kind between the granite of New-England, and the white albitic granite associated with primary limestone.

Connected with this mass is a very fine bed of graphic granite, one or two miles southeast of the village of Gouverneur. The feldspar of this variety is splendent upon a recent fractured surface ; it is a fine handsome rock. The feldspar itself is suitable, without doubt, for porcelain. This mass is also probably a continuation of the granite at the phosphate of lime locality, though it cannot be traced continuously to that place. Upon the western borders, it is penetrated by beds and veins of limestone, if these western beds belong to the same mass of granite which extends from Fowler to Antwerp. The central part of it does not furnish so many beds and veins of limestone as are found upon its skirts towards the west and southwest. I have brought this locality of granite before the reader, more particularly for the purpose of pointing out one in which he may observe the passages of one rock (as they are considered) into another ; the northern wing or prolongation being in parts decidedly gneiss, which, as it ranges west or southwest, passes clearly into granite.

Pursuing this rock in northwest and northeast directions, we find ridges or beds at numerous places in Gouverneur and Dekalb, each of which maintains the same general characters already described, presenting variations from granite to gneiss. In Hermon, it forms, over a wide extent of surface, the principal rock ; and still further east, in Edwards, it becomes a very important one. In the towns which succeed, as Canton, Russel and Pierpont, granite is largely developed. In the latter place, however, there is a greater preponderance of hornblende than farther south ; and here I observed that it contained hypersthene. The primary of this part of the county, too, is more distinctly gneiss, mingled with hornblende, as in Franklin county. We do not find the same relations to primary limestone ; at least it is far less abundant, and when it occurs, the beds are not so extensive.

According to my observations, the peculiar interchanges of one rock with another, and the constant connection with primary limestone, is confined mostly to the following towns, namely, Hammond, Rossie, Fowler, Gouverneur, Dekalb, Hermon, Russel, Edwards and Canton. In all which I have given in this list, there are the same associations, first of the rocks, then of the imbedded minerals. The intermixtures diminish towards the northeast ; and hence we find at Pierpont, and the towns towards Duane in Franklin county, a prevalence of gneiss and hornblende : they become, of course, darker colored ; and in the iron mines of Duane, we find some hypersthene, but it is never largely developed. Trap dykes become much more frequent in the region referred to ; while in Rossie, Dekalb, Gouverneur and Hammond, the ordinary greenstone in dykes rarely occurs ; and in saying *rarely*, I mean to put the expres-

sion in a saving form. I have not yet seen a specimen of trap, or a trap dyke, in the towns I have mentioned; and yet the rocks bear more of a plutonic character, than in the northeasterly part of St. Lawrence county.

Primary Limestone.

The range which this rock pursues, is much, if not entirely, the same as that of the granite. Beds and veins, or rather distinct ridges, are common in Hammond near Grasse lake, pursuing a northeast direction. They are found under similar conditions in Gouverneur, Dekalb and Hermon. With but few exceptions, the primary limestone occupies the lower grounds, and is projected up in low ridges. It is always coarse and friable upon the outside, or in a state of disintegration, and ready to crumble and break in the hand.

The largest beds of this rock are in Fowler, Edwards, Rossie, Hammond and Gouverneur, and in all it may be said to possess the same characters.

In the general account of the rocks of the Second district, the view which we are to take of this rock is detailed at length. It was my object in those details to present the facts which bear upon the two questions mainly of its stratification and origin. How far those views are supported and sustained by facts, the reader is at liberty to judge for himself; but it seems to be impossible to regard it in any other light than as an unstratified rock, and as of igneous origin, or a plutonic rock — one analogous to granite. Additional facts bearing upon this point might be gleaned from various sources; but as the most important appear to be already given, accompanied with illustrations, I deem it inexpedient to occupy farther time and space upon this subject. There is, however, one locality, though removed from all travelled routes, at which limestone lies between layers of gneiss. This is in Depeyster, or the western part of Dekalb, at the Osborn lake. The mass lies in parallel planes, between strata of gneiss. It is the coarse kind, and differs in no respect from that associated with granite; and though the rock in which it lies is distinctly stratified, this mass of limestone is as far removed from stratification as the beds of the same rock at Gouverneur. This limestone was exposed in searching for lead, during the *lead mania*. I found it contained small particles of pyritous copper, yet no lead, nor any mineral substance of value.

Gneiss and Hornblende.

The remarks which have been made in regard to the passage of granite into gneiss, apply with more force to the region of Gouverneur, Hammond and Edwards; but towards the northeast, they do not apply so well. It is here that hornblende, as a rock, becomes more associated with gneiss, and forms with it the surface rock.

A very large proportion of the county, however, is not in a condition to be examined with satisfactory results; and as is the case in Essex, more than one-half of the territory is a wilderness, or covered with forests. Even in those towns which are considerably settled, there are many obstacles to impede examination even on foot. This, with other reasons

stated, has prevented the exact determination of the geology at numerous places; and hence I have been obliged to rely upon established principles in designating the geology of these points, instead of observations made upon the spot. I trust few material errors will require correction by subsequent examinations.

In the above remarks in relation to hornblende, it is not intended to convey the impression that it does not occur in the southwestern towns; it is, however, rather a mineral than a rock, and is of frequent occurrence, but more frequently in distinct crystals. A range of gneiss and hornblende, of the ordinary kind, forms the shores of the St. Lawrence river southwest of Alexandria bay; and the same rocks also form the greater part of Wells' island.

This district differs also from the gneiss and hornblende districts already described. I stated in the preceding pages, that the granite of Alexandria, and I may add that of Hammond twelve miles north, is similar to the New-England granite. The same remark may be made in relation to the gneiss and hornblende. They occupy but a few miles of the surface; they all form low ridges, and never rise higher than moderately elevated hills; they furnish no interesting minerals, and none of the mines of the north are connected or associated with the rocks of this limited district.

Iron Ores of the Primary District of St. Lawrence County.

One very remarkable difference in the iron ores of St. Lawrence and Essex or Clinton, is found in the state of oxidation. In the latter counties, though the peroxide often occurs, it does not appear in that distinct state of peroxidation which it does in St. Lawrence; for here it is either in fine perfect crystals belonging to the forms peculiar to this mineral species, or else it is in the red massive or pulverulent state. It is impossible to offer a satisfactory rationale of this difference. One of the great features, however, of the section in which this oxide occurs, is the great development of the primary limestone, and I have been disposed to look upon this fact as in some way connected with the differences here adverted to.

The localities of the specular ores are quite numerous, though but few are really important, and furnish sufficient amount of ore to make it an object to work them.

One of the most important localities is the Parish mine, in Gouverneur. This mine is in gneiss. The ore formerly formed a hill in a small valley, fifty or sixty feet high, and in circumference twenty-five or thirty rods. The upper or superior part was the potsdam sandstone, highly charged with the oxide of iron, and some portions of it with sulphuret of iron. It appeared as if the whole mass of sandstone was raised up by some force applied beneath. Whether this conjecture is right or not, we find on either side the sandstone thrown off in different directions, and on each side dipping from the great mass of ore. Now upon the subject of the position of the specular ore when it occurs under this form, it scarcely admits of a question but that the mass has been projected upwards from below. It is true that the oxides of iron do occur interlaminated with sedimentary rocks; but the circumstances and condition of the masses of ore in St. Lawrence do not favor at all the theory that they have

been deposited from an aqueous solution, in beds or strata between the potsdam sandstone and the primary.

Since the remarks in the early part of this volume were penned, the printed sheets of Mr. Vanuxem's report have been placed before me; and inasmuch as this gentleman's views differ from my own upon the subject of the origin and position of the specular ores, I deem it but right that I should also place them before the reader of this volume. I shall therefore copy one or two paragraphs detailing his views:

"Specular ore is found in several places, associated with highly crystalline limestone. It
" exists near Lewisburgh furnace on the land of Mr. Lafarge near Harrisville, and in localities
" adjoining which belong to the Second district. When first discovered, there appeared to
" be a promise of abundance, but soon the spot was exhausted. It seems to have separated
" from the limestone by crystalline action, like gypsum and other minerals, being frequently
" enveloped in limestone. Where found, it is but a superficial mass; and though its matrix
" is mixed with primary rock, the origin of the two was subsequent to that rock, appearing
" *to have been local deposits of calcareous marl and oxide of iron similar to those met with*
" *in the gypseous region;* the marl and oxide separating from each other by crystallization,
" being placed in a position which facts elsewhere prove was highly favorable to this opera-
" tion. *That a deposit of iron was made upon the primary rocks subsequent to their eleva-*
" *tion and alteration of surface, is evident from the third deposit of iron ore,* which, near
" Lewisburgh furnace and in St. Lawrence county, is under the potsdam sandstone, in places
" intermixing with the base or lower part of that rock; showing also at Lewisburgh the same
" limestone and specular ore, the supposed associates of the primary rocks, intermixed with
" red ore; and thus proving a *connection with the potsdam, as intimate, if not more so, than*
" *could be discovered for the primary mass.*" *

In the preceding paragraph, I have italicized those expressions which I wish the reader to notice more particularly. The fact as stated in relation to the thinness of the ore at Lewisburgh, coincides with what I have elsewhere observed, and goes to show that my remarks in the early part of the volume, enjoining caution in incurring expense for the purpose of smelting this ore, were well founded.

The first point, on which I propose to speak briefly, is the opinion of my friend and associate, that the iron is a local deposit along with calcareous marl, analogous to the gypsum in the calcareous rocks. This of course is founded on the assumption that the platform upon which the specular oxide and limestone were deposited was the primary system; in other words, a sedimentary deposit, local in its origin like tufas and marls of any period. But what are the facts? We find, in the first place, the same mineral, with the same associates, in veins traversing gneiss with all the regularity of veins of lead or trap dyke. When this substance therefore occurs under this form, there is little probability that it is an aqueous or sedimentary deposit from above — an infiltration. Again, the calcareous rock associated with

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* Vanuxem. *Report upon the Geology of the Third District*, p. 267.

the specular is uniformly the primary limestone; and though no one will question the possibility of the crystallization of tufa and marl, and the separation of the oxides which may have been originally mixed with them, still the opinion that this limestone was a marl or a tufa is a gratuitous assumption: there is no fact revealed, in connection with those masses, which goes to show that such was originally the state and condition of those substances. Now, in pursuing these masses, there has been always a descent into the primary rocks, showing clearly that there is no platform of deposit *upon them*, but that it is uniformly *below or within them.* It is true that the potsdam sandstone is often above these masses, and is often highly charged with the oxide of iron; but how does this happen? Any porous rock, like this sandstone, would become thus charged when placed in contact with a substance of this kind, whether below or above. But in addition to the above facts, the rocks, both primary and transition, when connected with the specular ore, are broken and elevated; and instead of the deposits of ore and of limestone in the form of marl on a smooth unbroken platform, they are always and without exception disrupted masses, and both the oxide and the calcareous rock descend downward into those primary rocks which are broken and fractured: there is therefore really no spreading out of the main mass of ore upon the upper surface of the primary, without also a descent downwards into a fissure or vein clearly into the primary masses, and in some instances the depth has not been ascertained. A reference to my sections of the Parish and Kearney ore beds (p. 93), will illustrate the position and relations of the specular ore.

In the above remarks, I have spoken to two questions raised by Mr. Vanuxem's opinions, rather than one: 1st, to the opinion that the present oxide, and the limestone associated with it, were originally in the form of marl or tufa intermixed with the oxide, from which the latter separated by crystallization; and 2d, to the opinion that they were deposited upon the primary platform, since the elevation of the primary system.

As it regards the first, I have said that the opinion is gratuitous; and I now say, that admitting the theory, we may just as well admit that all the beds of primary limestone, and veins also, were deposits in the form of marl or tufa; for they are all alike. There is no essential difference in the limestone of the ore beds, and others not connected with them; and no fact can be better established, than that they all have one origin, and belong to one class of rocks.

As to the second opinion, or hypothesis, I have shown that the rocks, wherever these masses of ore exist, are in and connected with disrupted primary rocks; and though the ore may appear to be spread over the primary platform for a little space, yet they invariably go down into it; or, in other words, the masses come up from beneath, instead of having been deposited above.

I do not, however, in this place, propose to discuss the question of the formation of mineral veins; whether they are injected moulten masses, or have been separated from the adjacent rocks by an electro-magnetic agency. The only question I propose to raise is, whether the masses of specular iron and limestone were really mechanical deposits upon the primary, subsequent to its elevation; and this part of the hypothesis once admitted, I see no objection at all to the remaining part of the same, that the iron subsequently separated from the calcareous matter by crystallization. Such a result is not uncommon: it occurs not only among the

ordinary changes or phenomena of the great field of nature, but it takes place under our eyes in the laboratory, and in various manufacturing operations. But the first part of the hypothesis seems entirely unsupported by facts; and inasmuch as the real facts and phenomena are opposed to it, I have been led to adopt views at variance with those of my colleague.

The last part of the hypothesis contained in the foregoing extract, viz. that the specular oxide is more intimately connected with the potsdam sandstone than with the primary rocks, will require but one or two remarks; for if the views I have expressed are founded on fact, then the connection of the ore with the potsdam sandstone is wholly accidental.

We find that most of the beds of specular oxide, as the Tate and Polley beds or veins, are wholly disconnected with this rock; they are contained in gneiss; they are wholly mined in gneiss, and are not taken off from the primary surface, as they would be if deposited upon it immediately preceding the era of this sandstone. These are the facts as it regards connection with this rock. I infer, therefore, from these and numerous similar facts, that there is no necessary connection at all, but where there is a connection, it is accidental; and furthermore, the whole mass, with the ore and limestone, are essentially primary in their characters and position. That the masses reached the surface subsequent to the consolidation of the potsdam sandstone, I believe is a point which may be sustained by facts; but it is unnecessary to dwell upon it, as the facts themselves which go to support it have been already given.

So much space and time would not have been consumed upon these questions, if they were merely theoretical; but inasmuch as they are truly practical, and in this view highly important, it seemed necessary that we should know where to look for, and how to mine this species of iron ore. If they are deposited upon the primary platform, then certainly we need not expect to find them in the midst of the primary masses: we must pursue them upon that surface. This too will modify our views as it regards their permanence; and on this point, I agree with my colleague that they are less certain, and more liable to fail in quantity than the magnetic oxides. My reasons, however, are different from his: and while I believe these ores are always connected with masses within the primary crust, I by no means suppose that this connection may be demonstrated in every case. For instance, a mass of ore is entirely removed, and this removed part may have been connected with a larger mass; but this connection is now severed, and nothing remains to show its existence. If, however, the specular oxide is a local deposit in tufa or marl, then the whole deposit may be removed, and we have no prospect of finding it in the form of a vein in the primary rocks.

A very large proportion of the ore of the Parish and Kearney veins or beds is in the form of red stony matter, and often passes into the pulverulent state: in this condition, it is very unlike the crystallized specular oxide. The shape or form of either of these collections of ore has not yet been distinctly shown in the workings. They resemble superficially large masses, and originally covered quite an area; but in the present workings, the excavations descend into the primary rocks. I was unable to find lateral walls, or the precise extent of the masses on either hand. Below the southern angle of the Parish vein, the workmen had encountered a mass of shaly serpentine. In this rock I could not observe the continuance of the ore, but it appeared to rest upon it at this particular part of the mine. Serpentine, how-

ever, is often seen in the midst of the ore. I have already had occasion to remark, that serpentine is always found sooner or later in the beds of specular oxide. It also occurs with the magnetic oxide, especially in the large veins of Adirondack.

In the most of these beds of specular ore, we find large masses of the primary rocks, mostly of a siliceous kind. Besides these subordinate veins or masses of the carbonate of iron, fine geodes of quartz crystals are not uncommon. Sulphuret of iron, both in the state of proto-sulphuret and that of per-sulphuret, occurs in most localities: the former disseminated, decomposing, and passing into sulphate of iron; the latter in crystals, and more permanent in its form.

Besides the powdery and massive forms of the ore, it is often in fine lenticular crystals, or in fine brilliant scales, the *micaceous oxide* as it is termed, resembling graphite, and which has in a few instances been employed for blacking stoves; but, to the surprise of those who thus used it, the stoves soon became a bright cherry red. The ore sometimes is also in mammillary and tuberose forms, as in the hematitic beds, and it probably assumes those imitative forms under the influence of the same powers and principles.

The specular oxide, when unmixed with sulphuret of iron, has made uniformly a valuable kind of iron. The bar iron of Messrs. Fullers of Fullerville, is tough, and quite soft and malleable. When employed for castings, it has proved also as valuable as any ore; and particularly the castings from the Rossie furnace, owned by Mr. George Parish, bear the highest reputation in the Boston market. At one time, it was supposed that the crystallized masses of ore could not be worked; that they contained something poisonous; but this supposition has proved wholly erroneous and unfounded.

Specular Ore of Edwards.

A mass of ore which was explored in this place, deserves attention for the caution which it inculcates, rather than from its having been important in an economical view. This mass appeared in primary limestone, and seemed to be a vein extending along the rock nearly north and south. At the surface it was three or four feet wide, and bid fair, so far as indications externally appeared, to be a permanent vein. The mass was opened by Mr. Dodge of Gouverneur, directly in the face of the same. It was pursued regularly, and the ore removed: but its width soon began to diminish, until finally the whole of the ore was raised and removed; the vein or mass having been followed in its prolongation in each direction as well as downward, as long as any ore could be found. In pursuing this vein, serpentine, and a yellowish lean carbonate of iron, were very early encountered. After the ore was exhausted, it was determined to attempt to find or recover the lost vein by a lateral cut from east to west, so as to intersect it, provided it was lost by a shift in the position of the rocks. But after carrying out this plan as fully as necessary, the whole work was abandoned; having never encountered even a thin vein in the form of a *leader*, as they are sometimes called. Masses of the ore, in the cavities of the rock, were in one or two instances found, but nothing which indicated even the existence of the ore in the vicinity. The serpentine was sometimes ferruginous, as

well as the limestone; and it appeared that the principal rock beneath is a serpentine, or a mixture of serpentine and primary limestone.

I relate the history of this vein, for the purpose of illustrating the condition and state of many others in this section of country. In this instance the exploration was carried out to its fullest extent, and every effort made to discover the ore in some other position; but these efforts were fruitless, except so far as the results go to teach caution in the expenditure of money when an ore is associated as in the instance detailed. A similar error has been committed by a mining company established at Troy, Vermont. In this case, the ore is the magnetic oxide, forming a very distinct vein, or long mass in the serpentines of the Green mountain range, which is somewhat different from that of Northern New-York. The vein appears in the face of a serpentine cliff, and extends twenty or twenty-five rods in a north and south direction. At the southern extremity, it appears to divide into two veins, with a divergence to the right and left of the axis of the main vein. Each of these prolongations run out, or become thinner, and finally disappear, not only in the direction of the strike, but also downward; for the mass becomes wedge-form, and merely sinks a few feet into the serpentine, being as it were *pinched out*. At the central part of the vein, where it is thickest, it is opened. At the surface, it is ten feet wide; but in working downwards ten or fifteen feet, its width has considerably diminished; and inasmuch as the general indications go to show its disappearance and entire thinning out, I have very little doubt, after knowing the facts in regard to the ores of St. Lawrence, that the whole mass will be entirely removed, and the large and expensive establishment left without a certain source to supply their furnace with ore.

Without venturing to generalize on an insufficient number of facts, I will barely remark, that all and every fact which has been observed in the northern district, goes to show that mining in serpentine, and even in primary limestone, is attended with risk. The risk consists, not in mining or using the ore as far as it can be obtained, but in the expenditure of capital in buildings and in furnaces, under the expectation of running them when the ore is uncertain in amount, or depending upon a mass or vein which is connected with one of these rocks.

I have deemed it proper to digress, in order to give me an opportunity of speaking upon this subject; knowing very well that the progress of the iron business requires to be founded upon a sufficient basis.

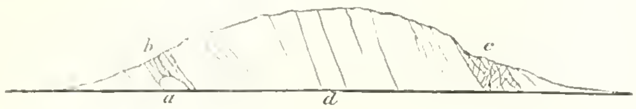
Tate and Polley veins of Specular ore.

These veins are contiguous to each other, but do not appear to be connected. Both are situated upon the side of a ridge running northeast; one upon the east, and the other upon the west side. The rock is gneiss, dipping to the northwest. The ore of the Tate resembles that of the Parish vein, being of a bright red color and earthy in its texture. The Polley vein has much of the same character, but contains much quartz: it is a leaner ore. These veins are both embraced in gneiss, and are wholly unconnected with the potsdam sandstone. In this particular, it is important to observe, that neither of these veins is connected with

sedimentary rocks; hence the opinion which has been sometimes expressed, that the specular ore is more nearly connected with the potsdam sandstone than the primary, is not supported by the facts of these two veins.

The following cut will serve to illustrate the relation of the veins of ore under consideration:

87.



b, Tate vein; *a*, Serpentine; *d*, Gneiss; *c*, Polley vein.

The similarity of these veins to those of Parish and Kearney, is carried out by the presence of serpentine.

Another vein of the specular oxide has been found upon the farm of Mr. Hitchcock, about three miles west from Dekalb village. At this place only a few openings have been made; they were insufficient to enable me to form an opinion of the amount of ore. It is in gneiss, and unconnected with the potsdam sandstone.

Magnetic Ores.

This species of ore is found only in the eastern part of the county, where, in the circuit of fifteen or twenty miles, several veins are known to exist. They are all in the unsettled parts of this district, and have not been examined with a particular reference to their value. They are of course in a region which is well wooded, and favorable in all respects to the manufacture of iron, except the distance from market, and the heavy expenses which must be met in so much land transportation. At present it seems unwise to attempt the manufacture of iron so distant from water communication, unless the ore possesses more than ordinary value.

Magnetic Ore of Chamont.

In the township of Chamont, in the southeast part of this county, one of the largest ore beds in the county has long been known. Twenty-two or three years since, a large quantity of the ore was transported to Canton for reduction. It is situated upon the Oswegatchie river, near the crossing of the Albany road. The vein is in a hill or rocky eminence running east and west, about one hundred feet high on the south side, and fifty on the north side. The top of the ridge is a naked and smooth rock, about fifty rods wide, and near a mile in length. The whole of the hill is magnetic iron and quartz or white flint, a pepper and salt mixture. Some parts are richer in iron than others, but none are destitute. Some portion of the mass is nearly a pure oxide, a magnet taking up about ninety per cent.; while others yield, by this mode of trial, only fifty per cent. The ore is fine-granular, the grains being only of the size of white mustard seed.

This ore is strongly magnetic, and probably is composed of a larger proportion of the protoxide than usual. At those places where it has been opened to a depth of five or six feet, it appears richer than upon the surface. This is a result which I should expect.

This mass of ore resembles the Palmer vein in Clinton county, being black, fine grained, and strongly magnetic. Of the result of the trial in reducing it, and of the kind of iron it made, I have never been informed. It may be regarded very safely as a valuable ore, inasmuch as those substances which usually injure iron are absent; and furthermore, the gangue is one which indicates a favorable result in reduction. The mine is in the vicinity of water power, wood, etc.; but is far removed from water carriage, and other means for cheap transport.

There is another vein in this vicinity, discovered by Mr. Dodge of Gouverneur. The ore is richer and coarser, even in large cleavage crystals. It is black and strongly magnetic. It is probable this will be found strictly a mineral region. The rock is the hypersthene, and hence there is a remarkable similarity to Adirondack in Essex.

On township No. 10, about eight miles from Russel, a vein of this species of ore was discovered three years since. Not having visited the place, I am unable to give an account of it farther than to say that the specimens of the ore appeared well, being rich, and free from substances which are injurious to iron.

The hypersthene rock which appears in this section of the country, is probably unconnected with the great mass in Essex, and it is probably quite limited in extent. The opportunity for the examination of this part of the county was unfavorable for acquiring facts. I would therefore be understood as speaking with caution in relation to the surface rock of this whole region.

Of this region I may, however, remark in general, that adjacent to the Oswegatchie, the land is rather low and swampy, and the underbrush is thick. In some tracts, the timber is wholly or mostly black cherry. In the neighborhood of Cranberry lake, there is considerable pine. But, upon the whole, this section of the county is inferior to that upon the St. Lawrence river.

Bog Iron Ore.

Bog ore is found in large quantities in Hermon, on the land of Mr. Kent. The beds are five or six, and even ten feet thick; the ore is found underlying eight or ten acres.

The peculiarity of this location arises from its connection with the rock which furnishes the original materials composing the ore. The rock surrounding this great bed is highly charged with sulphuret of iron, which, decomposing gradually, has furnished this large amount of ore; and should any part of it be removed, its place will be supplied in the course of a few years. In consequence, therefore, of this source of constant renewal, beds of this description become inexhaustible.

One objection which lies against this ore, is the presence of sulphuret of iron. This objection may be obviated in two ways: First, by roasting, and secondly by exposure to the air

in heaps, in which the decomposition will go on, and be completed in the course of two or three years. Ores which were useless, and were in consequence thrown away, after lying exposed to rains and other atmospheric agents, became valuable. The fresh ores may therefore be thrown into running water, where the soluble sulphates will be washed out as fast as formed; and after the process is completed, the ores will be suitable for the furnace.

In this immediate neighborhood, other smaller beds of bog ore are known, but they are too unimportant to require a description.

Bog ore frequently accumulates around springs in low swampy places. In these instances, its origin is different from that of the bed of which I have spoken above. Usually this ore is a mixture of the oxide and carbonate; and the water being charged with these substances, when it reaches the surface, deposits them in consequence of its diminished solvent powers, occasioned by parting with carbonic acid. The accumulation of ore in these places is usually too small in amount to be of any account in the manufacture of iron.

Bog Ore of Brasher, Fowler, Gouverneur, &c.

The towns adjoining the St. Lawrence river, or those upon the lower levels, are favorably situated for the accumulation of bog ore, peat and marl. Accordingly many localities of each of these substances exist, and sometimes in the form of extensive deposits. In Brasher and the neighboring towns, bog ore has been discovered in sufficient abundance to supply several forges, and employ many workmen constantly in the iron business. The qualities of the ore, as it occurs in the lower level, is better than that in Hermon, which is derived immediately from the decomposition of the rock. The Brasher ores are free from pyrites, and make good castings or bar iron. The quantity of manufactured iron from one furnace in this place amounts to eight hundred tons annually.

The beds in this place have been dug out partially twice: after the removal of the first crop of ore, the space is filled again in fifteen or twenty years. The ore rarely yields more than fifteen per cent; but it works remarkably easy, and forms a soft tough iron.

The extent of the Brasher beds is greater than that of any others which have been discovered; they are five or six miles long, and the average thickness is two feet. Several furnaces are supplied with ore from these beds, namely, those of Brasher, Waddington and Norfolk, and one at Westville is also partly supplied therefrom.

At Fowler, beds of bog ore have been discovered, and used in the furnace at Fullerville.

In Gouverneur is a bed containing a great abundance of ore, in which there are large quantities of twigs, and branches and roots of trees of all the kinds which grow in the neighborhood. It contains too large a proportion of sulphuret of iron, to be used without roasting.

In Canton, also, numerous deposits of this kind are known; but they are generally too limited in extent to become important.

The above details are deemed sufficient to meet the objects of this report. They are matters mostly entirely local; though upon a general view, they bring out more satisfactorily the resources and wealth of the county.

Concluding Remarks on the Iron Ores of St. Lawrence.

The iron ores of St. Lawrence county belong, it will be observed, to three different kinds or species ; the specular, the magnetic, and the bog ore. The first is found in many places, but quite limited in extent. The Parish and Kearney, and the Tate and Polley beds, are large and important, and capable of supplying ore to any amount. The Parish and Kearney beds in reality belong to one mass ; and the indications in that neighborhood show that the beds may be opened at several different places, in addition to those from which the ore is now raised.

In these four beds or veins mentioned above, not so much danger is to be apprehended of exhausting the ore, as at Edwards, an account of which has been given.

The magnetic ores being confined to the extreme southeast part of the county, in a region which is unsettled and not well explored, I am not able to give an opinion of their true value. Much depends upon the facilities of intercourse with a market. It is certain that before they can be made valuable, roads of a durable kind will have to be constructed. The face of the country is favorable to enterprise on every other consideration. With a good road, it appears a feasible project to bring out the magnetic ores, after they have been separated from earthy matter. In this state, they would be important to the furnaces and forges now in operation at several places ; and in particular they might be added with great advantage to the specular and bog ores, either for castings or bar iron. The quality of the iron will not only be improved, but the whole can be worked with greater economy in fuel.

As to the quantity of iron ore in the southeastern townships, I have no hesitation in saying that it is inexhaustible. The Chamont ores in particular, together with other veins in the immediate vicinity, are remarkably developed, and they will become richer and more valuable as they are explored. The deeper the bed is worked, the richer is the ore, and the easier will it work either in a forge or furnace.

The above remarks are intended to show that this county possesses large resources for the iron business ; that many advantages accrue from the possession of the several kinds of ore which have been mentioned, for the purpose of mixing, so as to adapt them to the qualities of the iron it is wished to make or produce. It is rare that such a combination of circumstances exist for the production of this important article, in a territory no larger than this county.

Rensselaerite.

This substance, usually known as *soapstone*, was specifically separated from that rock early in the survey ; and inasmuch as it forms large masses, greater by far than most other minerals, it appeared proper to describe it as a rock, rather than a body belonging to mineralogy proper. In this respect, however, it may be considered as analogous to hornblende, limestone, and a variety of other substances, which may be placed with propriety in either department. They are both simple minerals, and rocks. The geologist describes them, because

they form large and important portions of a district, or of a geological system; and the mineralogist necessarily describes them, because they are simple mineral substances, existing in some places as individuals, the power of crystallization having operated upon, or *individualized* them, to speak in the language of the crystallographer.

This substance, like hornblende, exists both in amorphous masses and in crystals. When in crystals, it has the form of pyroxene; an oblique rhombic prism, and a distinct cleavage parallel to P. Its hardness equals 3.5 to 4.0, and its specific gravity is 2.874. It is strongly coherent. Before the blowpipe, it fuses with difficulty into a white enamel. Moistened with nitrate of cobalt, it assumes a pale flesh-red. In this State, it is associated with primary limestone, usually in amorphous masses, with a crystalline structure, and sometimes in distinct crystals.

Crystals of this substance were first found in Canton, in limestone. In the limestone, upon its irregular surfaces, were many small slender crystals, possessing a regular cleavage. I state this fact, for the purpose of doing away the impression that these forms, although called crystals, might have been *pseudomorphous;* for pseudomorphs never possess a regular structure, or a cleavage. With these facts, it is clear that rensselaerite differs from soapstone or steatite, by its hardness; it is softer than pyroxene, and is not a pseudomorph, in consequence of possessing the requisite characters of a crystal. To these facts, I may justly add, that it is not a mixed mineral like granite, consisting of soapstone and pyroxene. To the eye, even when assisted by the microscope, it is homogeneous throughout. If mixed, it cannot be shown by any mode of inspection; and as analysis cannot demonstrate such a condition, we have full liberty to claim it as a simple mineral species.

But this substance claims attention in this place as a rock, and as such I shall describe it.

This mass, though it appears homogeneous, yet is often associated with serpentine and primary limestone; but it does not, as a rock, form with either of these bodies a compound analogous to that of serpentine and limestone: it rather exists by itself. It presents a great range of colors, as white, grey, brown verging to black. Its structure is usually compact; the outside is more compact and whiter than the interior, which is often slightly crystalline; but masses are often found which are crystalline throughout, like calcareous spar or sahlite.

Rensselaerite resembles serpentine; it forms irregular masses, rarely continuous over sixty or seventy rods. In some instances serpentine appears to pass into rensselaerite, and the connection is so intricate that it is difficult to draw a line of distinction between them. Rensselaerite is never so hard but that it may be cut with a saw, and hence shaped into any desirable form. When cut into pieces a quarter of an inch thick, it is translucent; and if the mass is white, it has the agreeable translucency of porcelain. Like potstone, it is refractory in the fire, and is not liable to crack when heated suddenly. A strong white heat hardens and whitens the mass; and in this respect it resembles soapstone, for which it may be substituted.

As a rock, rensselaerite belongs to the unstratified division of the primary system, occurring in masses similar to serpentine or granite.

There is a locality of it in the town of Fowler, on the Belmont farm, extending irregularly

half a mile or more; in some places the rensselaerite is black, and is traversed by seams of white satin spar. Near this farm, or upon the adjoining one south, it occurs in larger masses, associated with primary limestone and quartz; the latter is rose-red, and presents more of a vitreous aspect than usual.

Another locality is in Edwards, at the mine of specular oxide. This is white, inclining to grey. This locality has furnished the material for inkstands, some thousands of which have been manufactured by one individual.

On the road from Edwards to Russel, this rock occurs in several large masses near the road.

Another locality of this substance is on the western side of the Oswegatchie, about half a mile north of the village of Dekalb, near a bridge, and the rock is half or three-fourths of a mile long. It is white, but less pure than at other places, in consequence of being mixed with quartz.

This rock is frequently intersected with veins of quartz. Sometimes the quartz is spread smoothly over its surface, and in others dips down into its substance, checking it in various directions, though without regularity.

Rensselaerite occurs also in Hermon, Gouverneur, and in Canton. In the former place are large masses, which possess a crystalline structure throughout. In Canton, near the copperas works, it may be found in small but distinct crystals.

Origin of Rensselaerite. In the general account which I gave of the rocks of the Second district, I advanced the opinion that rensselaerite belongs to that class of rocks which are supposed to have an igneous origin. All the phenomena connected with the mass, at the different localities I have cited, go to sustain this opinion. It is associated with rocks of an igneous character; it is unstratified, and forms large irregular shaped masses, with no divisional lines similar to those of gneiss or mica slate; it is even rare to be able to distinguish natural joints. We are able, therefore, to add another rock to the unstratified class or division. It is analogous to serpentine in the mode in which it appears among other rocks; but it does not, like that substance, form with limestone a distinct aggregate. It is often found, however, in distinct crystals in limestone, and in this respect it resembles hornblende and pyroxene.

Purposes to which it is adapted. In an economical point of view, rensselaerite is of some importance. It may be used for a variety of small domestic articles, but it would be still more valuable as a lining for stoves, grates, etc. It receives a good polish; and as it is quite tough, and at the same time soft, it may be turned in a lathe, or cut into a variety of articles both ornamental and useful.

Steatite or Soapstone.

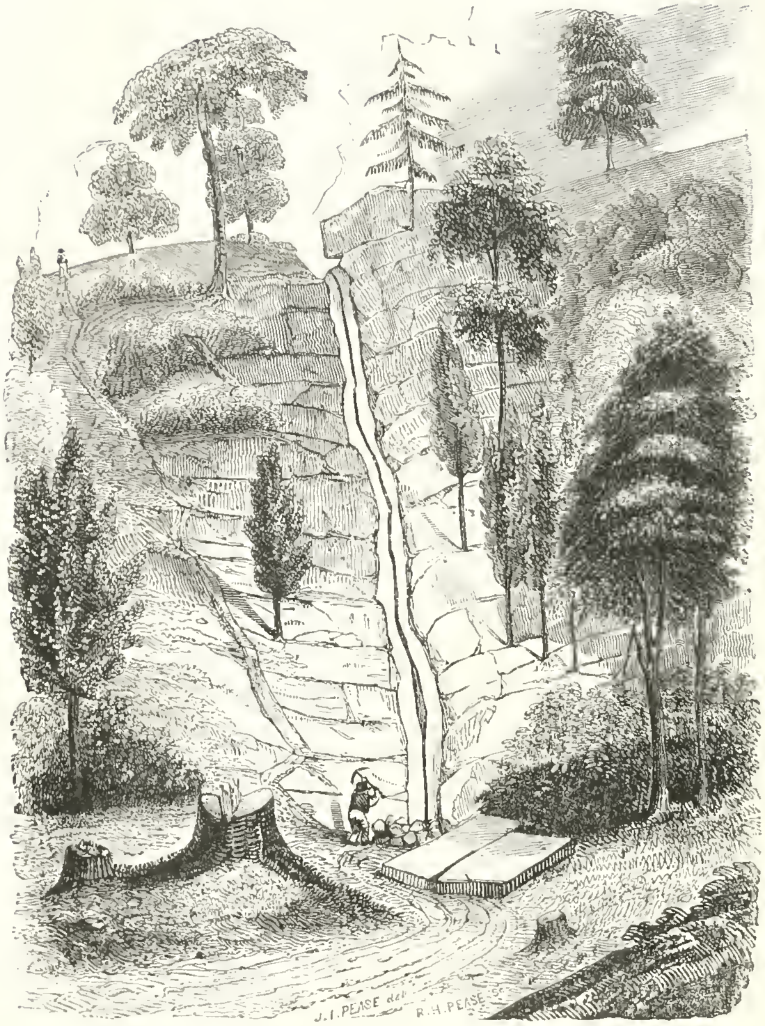
This substance is much less common in the northern counties, than in the primary of New-England. All the central ranges of the Green mountains abound in steatite, differing in

different localities but slightly. In some places it is white ; in others it is green, either light or dark ; but as a whole, wherever it appears in these long ranges, it is nearly the same. In the primary of New-York, however, it is extremely scarce ; only three or four localities being known.

One of these is in Fowler, not far from the Belmont farm. It is nearly white, soft, and distinctly foliated. It is in a bed of gneiss, into which rock it appears to pass. In fine, it has a perfect resemblance to the soapstone of the Green mountains.

Again, in the same neighborhood, about half a mile west, soapstone is found under the same conditions and under nearly the same circumstances, only that here it is associated with tremolite.

88.



Sketch showing the eastern termination of the Coal Hill Mine, Rossie.

Galena and Lead.

During the six years last past, great excitement has existed on the subject of lead, and much speculation has resulted from its discovery in this and the adjoining counties. An endemic mania has prevailed in consequence of the opening of a few veins of galena, particularly the one found in Rossie, which is by far the most important. This mania has now, however, wholly subsided; and as in all cases where a fever has raged, the reäction has reduced the

public pulse to a state considerably below par. These circumstances do not, however, diminish the interest of the veins of lead in a scientific point of view: they still furnish facts of importance; and should the business of mining prove unprofitable, still the principles which have been established in the examination of these veins remain important, and applicable to future business, whenever they shall be needed by future discovery.

Coal Hill Mine.

The first vein which I shall notice, is the Coal Hill mine, sometimes called the *Nash vein.* A view of its eastern termination in the face of a ledge of gneiss, is given at the head of this article. The vein is four feet wide, and is filled with calcareous spar and galena, the latter having only a width varying from two or three inches to eighteen: probably the average width is about ten inches. Its direction is S. 82° E., and its dip about 85° N. The galena is distributed through the gangue of spar rather sparsely at some points of the vein, but generally it is disposed in nearly parallel lines in the form of subordinate veins. Large masses of lead are occasionally met with, weighing several hundred pounds. It occupies, as a whole, the central part of the gangue, varying in width at different points; often running out into a narrow string, which, after continuing quite thin or narrow for a time, widens out again to its usual dimensions. In the distribution of the galena in the gangue, we find it similar to that of the magnetic oxide of iron: the arrangement, as a whole, scarcely differs. We find the same thinning out, the same parallelism in the lines of ore in each case. The iron, however, is developed upon a much larger scale.

The Coal Hill mine has been worked to the depth of two hundred feet. The mining has been carried on by two distinct companies; the eastern division or section by the Rossie Lead Mining Company, and the western section by the Rossie Galena Company. Of the profits which have accrued to either of these companies, the public have never been furnished with official reports. There is no doubt, however, but losses have been sustained by both companies. The pressure of the times, the fall in the price of lead, but more than all, the interest upon the capital of the purchase money, not only must have been a great drawback on immediate profits, but must have rendered the prospects in future hopeless. That the owners may succeed in working this vein at a profit, is highly probable. But upon these points it is unnecessary to dwell.

Coal hill is composed of gneiss, with a mixture or interlamination of black hornblende and mica. It is a tough rock, and but slightly affected by the weather; it is distinctly stratified, but its strata are often remarkably contorted and twisted; and although these phenomena are not particularly common in the immediate neighborhood of the veins, yet they may be observed over the whole country. The surface is quite uneven and broken by protruding ledges, whose ranges vary from northeast to northwest; it is in a line nearly perpendicular to these ranges, that the veins of lead are found. The Coal Hill mine was first discovered upon the face of one of those ledges, which was between sixty and seventy feet in height. When first uncovered by the removal of loose stone and rubbish, it presented the appearance represented in the cut

(p. 354). The whole vein in the face of the ledge was thus laid bare, the galena appearing in the central part of the calcareous spar, in a white or silvery stripe, being coated with disintegrated carbonate of lime, mixed, it is said, with a small quantity of carbonate of lead. The sulphuret of this vein is coarse crystalline as a whole, but mixed occasionally with the fine grained and more silvery looking ore; but the latter is always, or has been thus far, only in a small proportion to the coarse-grained galena.

A fact of some consequence to be known is the low level of the region in the neighborhood of the mines, and indeed of the whole town of Rossie. It is scarcely over one hundred and fifty or two hundred feet above that of the River St. Lawrence; and yet a stranger passing through this section of country would very likely call it mountainous. The hills are frequent and steep, and the valleys at their bases are upon the level of the St. Lawrence. Hence, in mining, where the mines are even situated upon the highest of the hills, the shafts are soon sunk to the level of standing water.

Leaving out of view all economical considerations in regard to the Coal Hill mine, there are several points which are interesting both to the geologist and mineralogist.

Soon after the vein was opened, a large geode, or cavity termed a *water course* by miners, was struck. This course was found lined with crystals of galena, whose edges bounding the faces were three inches in length. Some of the single crystals weighed thirty-five pounds; generally they came out in groups, whose aggregate weight exceeded one hundred pounds; and it was not uncommon for five or six crystals to be aggregated together, in which case four or five faces of each crystal were well exposed. Some of these large crystals presented smooth polished faces, but generally they were rough and uneven; and frequently they were coated with carbonate of lime, which was readily detached, leaving a smooth polished surface. The crystals, however, instead of being perfect cubes, were more or less modified by the replacement of the solid angles. One of the common modifications was the passage of the cube into the regular octahedron, by the replacement of the solid angles; more rarely, the edges were replaced; and in a few instances, both modifications appeared together. The large crystals were usually confined to the water-course first opened; all parts of the vein, however, furnished smaller cavities, which were invariably lined with crystals of galena and calcareous spar. Among the latter we found small crystals with fine polished surfaces, perfectly finished in all respects, and possessing the brilliancy and lustre of polished steel. The smaller crystals have the same modification as the larger. Associated with galena in the geodes, are crystals of sulphuret of iron, which for brilliancy and finish exceed any which have been found in this country. The ordinary form is the cube, with the modification leading to the pentagonal dodecahedron. The replacements upon the edges in this case vary from a slight removal of an edge to a deep truncation, ending with the perfect form of the dodecahedron. A less common and more complicated modification, is the combination of the octahedron and rhombic dodecahedron with the cube. Such are some of the common or predominant forms, both of lead and pyrites, at the Coal Hill mine: the details in relation to them belong to my colleague, Prof. L. C. Beck, the Mineralogist of the Survey.

Equally interesting with the above, are the forms of calcareous spar; and here, as at most other localities where a mineral substance is well developed, certain crystalline forms prevail to the exclusion of others. The primary faces are usually preserved, the modifications rarely proceeding so far as to obliterate them entirely. The angle most subject to alteration, is the obtuse solid angle, which is replaced by one plane inclining equally upon the adjacent faces. The other solid angles liable to replacement, are both the lateral and terminal edges, which are uniformly replaced by three planes resting on the primary faces. All these modifications are found present in the same crystal. But in all the crystals of the mine there is a tendency to the formation of twins: it is, in fact, more rare to find single crystals than twins; and what is exceedingly interesting in crystallography, is that the plane which bisects the crystal diagonally, and along which it may be split, is visible, one half of the crystal lying upon one side and the other half upon the other, but in reversed positions. These forms, however, are not confined to this mine, but occur throughout this region, in most of the localities where lime is found in a crystallized state.

Besides the modifications already noticed, there is a form under twenty-four faces; that is, each of the six primary faces of the crystal has standing upon it a low pyramid of four faces, striated parallel to the primary edges. It is one of the rarest forms yet met with in this vein. But it sometimes happens, that when the obtuse solid angle has been replaced, nature seems to have altered her mind, and after the plane is well formed, she has built it up so as to make the primary faces and angles complete. Her progressive steps in this case are seen in the sprinkling of the whole surface of the replaced or secondary face with crystals of sulphuret of copper or iron, and upon this surface thus covered, the form is completed. At least it has all the appearance of having been thus modified, and then completed in the order I have stated. I can conceive of no way or mode by which this deposit of crystals upon a plane surface could have been effected, unless that surface was truly a plane at the time of their deposit. This process, however, is not confined to a single plane, modified as stated above; but it is not an unfrequent discovery to find all the primary planes covered with pyrites, and upon these planes, thus clearly made visible, an entire secondary form built up around and upon the primary faces.

In these remarks, I speak of all the modifications as having been consecutive. Whether such will be deemed literally true and correct by crystallographers, I am unable to conjecture. The formation of crystals, however, in this vein, does appear often to have been effected by several successive steps: and not only do additions to preëxisting solids appear to have been made, but the matter is frequently of a different kind, and often of a different colour and lustre. The nucleus, for instance, of a crystal of carbonate of lime, is transparent; while around and investing it is a material which is quite opaque, but arranged in perfectly distinct planes. Perhaps there is nothing mysterious in this mode of building up crystals. It has, however, struck me that many real illustrations are furnished in the forms and changes here described as occurring by successive additions, in order to complete and finish the solids as we now find them; or, in other words, these solids have been made as theory proposes, when we attempt to explain the mode in which one form is converted into another by the successive

addition of particles to certain planes. Changes undoubtedly are taking place continually in the forms of the crystals, inasmuch as they are immersed in a fluid which has some solvent power. The surface often presents the kind of appearance which we observe where alum, or any soluble salt, has been partially dissolved. And again, clusters of crystals appear as though recently formed, being mere skeletons; though it is not easy to decide whether they are recent and unfinished, or merely crystals which have been partially redissolved.

Some of the water-courses which were opened during the mining operations, not only contained a large amount of water, but it existed under great pressure. One course in particular, when pierced, spouted water between fifty and sixty feet, for two days, in a horizontal direction.

From the water thus filling a cavity or space, we may reasonably suppose that deposits of particles of carbonate of lime will take place; but the phenomena will unquestionably vary, and sometimes the water, instead of parting with its soluble matter, will actually act upon and redissolve the calcareous portion of the vein. In truth, we have reason to suppose that the state and condition of the materials are constantly changing: at one time, depositing anew upon the faces of crystals already formed; and at another, redissolving and taking up the solid matter of which they are composed. Without doubt, the electrical state of the interior of a vein has much to do with the physical forms of the bodies contained in it; and as this state is liable to constant or at least daily variations, some additions to or subtractions from the crystals may be expected. All these changes, according to the discoveries of the most able philosophers, must take place in those materials only which are soluble; for experiment and observation prove that the electro-magnetic agency or force is confined to bodies which are dissolved in an aqueous or other liquid menstruum. Solid bodies, as well as aëriform ones, remain unaffected by the electro-motive forces. For this reason, the filling of veins by this agent or power is rendered at least doubtful; although the transference of a single substance to a distant place, and its deposition there, are facts agreeable to experiment and observation.

The Coal Hill mine is, without doubt, the most important vein which has been discovered in Rossie. A very large amount of lead has been made there. Previous to January, 1838, 2,029,415 lbs. had been smelted. The quality of the metal is good, being very soft, and well adapted to the manufacture of white lead.

Victoria Mine.

The vein which ranks next in importance and size, is the Victoria mine. This is about three-fourths of a mile east of the Coal Hill mine. Its range is S. 84° E. At the depth of forty feet, it is two and a half feet wide. It does not yield so much lead as the vein described above. Its gangue is calcareous spar, but far less crystalline than in the Coal Hill mine.

This mine strikes across a marsh about eighty rods wide, and then rises upon a high headland, where it reäppears. It is then known in the vicinity by the name of *Union mine.* The whole width of the mine appears to be greater in this western prolongation, without an increase of lead. It is said, however, to be worked with profit.

Another vein crossing the Coal hill, is called the *Robinson vein*. It has been explored less, and the impression among miners is that it is too unimportant to be worked. Its direction is S. 75° 45′ E. Its gangue is similar to that of the veins already described.

During the last two years, circumstances have induced the proprietors of the two most important veins to cease working them. They have however been worked partially by the laborers who had been previously employed, and it has been said that they have thus far worked them at a profit.

In addition to the above mentioned veins of lead, others have been discovered in different parts of the county. The first claiming notice, is called the *Wilson vein*. It is in the north part of Gouverneur. Its gangue is calcareous spar, or rather the vein itself is in primary limestone; and though it pursues a direct course nearly east and west, yet its walls are not well formed. It occurs in masses or bunches, with occasionally an uninterrupted continuation of the ore. It may be traced half a mile, by small bunches of lead upon the surface. It is not, however, likely to prove important.

Another vein exists at Mineral point on Black lake. Its course is east and west, with a gangue of calcareous spar. Among the veins which present some prospect of being valuable, this is one. It is, however, situated upon low ground, and in the immediate neighborhood of the lake, so that some additional expense would be required to work the mine. The ore at this mine is finely crystallized, and it has furnished some fine specimens of cubic crystals.

In the southeastern part of the county, several lead veins have been discovered, but none are important, or of any value. It may, however, be useful to state a few facts connected with them:

1. The Leroy vein, runs N. 28° E. It is a mere string, or narrow vein.
2. The Pitcairn vein, runs N. 37° E.
3. The Garlic vein, runs N. 43° E.

The surface rock is gneiss. The Pitcairn vein is in primary limestone, or that variety which is mixed largely with serpentine. It is, however, scarcely an inch in width, and never would have been noticed without the aid of the high excitement which existed during the lead speculation in this county.

There are several other veins in this county, partaking of the character of those just described. I have not, however, been able to obtain facts which are of any importance in a scientific or practical point of view. It will be observed that the richest and most important lead veins run in directions nearly east and west; and the farther they depart from this direction, the poorer they are. On the contrary, all the iron veins in St. Lawrence, Clinton, Franklin and Essex counties, pursue a course nearly north and south; and those in general are the richest and most important, whose general direction approaches the nearest to this course, while those whose course is easterly and westerly have rarely been worked: and without fear of conveying a false impression, I may say that those iron veins only are important whose strike differs but a few degrees from a north and south direction. These facts are, however, only confirmatory of what has long been known in the mining districts of Europe.

Observation had long since proved that a given mineral substance, occurring in veins, was liable to be unproductive when it deviated from its usual course. It is a matter of some importance to be able to find, in this country, not only the same general arrangements and associations as in Europe, but the same leading facts in the distribution of mineral matter.

LOWER MEMBERS OF THE NEW-YORK SYSTEM.

I have divided the surface rocks of this county into three classes: the primary, which occupies the whole of the eastern and southeastern parts; the sandstone, which is nearly central; and the limestone, which occupies a belt along the St. Lawrence river. A very large proportion of the district occupied by the first class of rocks is still covered with forest, and is only generally known, or it has been particularly examined in only a few places. The other districts are well known, and they are as different in character from the first as possible. The only mineral productions are derived from the first by transports, as the bog iron ores, or else are confined to the rocks themselves.

Potsdam Sandstone.

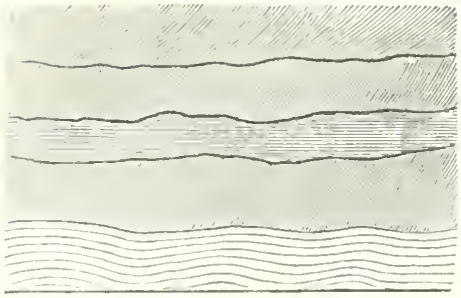
The quarries of this rock at Potsdam are situated upon the De Grasse river, three or four miles southeast of the village. They are sixty or seventy feet thick. The rock at this place is composed of moderately fine particles, and very uniform in size; hence it is even-bedded; and what is worthy of remark, is the perfectly smooth and even surfaces which the layers present. Thin sheets of the rock, twenty-five or thirty feet square, can be raised without difficulty. The layers vary in thickness from one inch and even less, to two feet; but each wide layer, though no distinct seam appears, may be separated into many, so perfectly fissile is the rock. The general color of the mass is yellowish brown, but the tint of each layer differs somewhat from those adjacent to it; so that the rock, upon the fractured edges, wears a slightly striped aspect.

This quarry furnishes the most valuable stone in the State, being so perfectly workable and manageable, especially when first raised, that few materials for building could compete with it, if situated near a market. As it is, the Potsdam sandstone is largely employed for building in the adjacent towns. It has been transported sixteen miles overland for this purpose. The buildings constructed of this material present a remarkably neat appearance; and as the rock is free from sulphuret of iron, it does not appear stained and soiled after a few years exposure to the weather.

In addition to the common purposes of building, this rock is largely employed as a firestone; hence it is used for the hearths of furnaces, for which purpose it is peculiarly well adapted, by reason of its granular structure, and the entire absence of crystalline action.

The phenomena presented by this rock are rarely of an interesting kind. The stratification is usually quite perfect, though we frequently saw instances of diverse stratification, as in the following diagram:

89.



This mass, if examined on the borders of the primary, is often exceedingly disturbed and broken: the layers are often broken into short pieces, and cemented together again. An interesting locality exists in Dekalb, a few rods north of the village, and by the road side. In some instances the strata are crushed.

This rock presents fewer varieties or kinds here than in Clinton county: the more regular form is preserved. It is, however, often crystalline, in which state it assumes the form and character of granular quartz. The lower portion is generally formed of a conglomerate, is often quite coarse, and fragments of quartz as large as a peck measure are common. The materials from which this rock is formed in this county, have been evidently derived from granite. Fine particles of pale brown feldspar are interspersed through the rocks, and the peculiar character of the quartz indicates such an origin; but a fact which sets this question at rest, is found in the composition of the lower layers. Thus, at Dekalb, a conglomerate, or rather breccia, is found, which is composed of pieces of granite containing a peculiar variety of tourmaline wholly confined to this particular locality; and while the origin of the materials composing the rock is thus proved, we also prove that they were not transported far from their original or parent beds.

Calciferous Sandrock.

The limestone region is composed of this rock. The reader is therefore probably aware, that in some places, particularly near the junction of the potsdam sandstone, this also wears much the aspect of a sandstone; but at a distance from their line of junction, the rock bears the aspect of a limestone.

This rock forms a belt or border along the St. Lawrence river, ten miles wide. Towards Ogdensburgh it is much narrower, nearly runs out at Morristown, and entirely disappears before it reaches Hammond. This rock is very much concealed by drift and soil throughout this whole region: it lies low, and is never upraised much above the common level of the country. The following towns are based upon this rock, namely, Lisbon, Madrid, Louisville and Massena; and it extends over a part of Brasher and Norfolk.

Lisbon. The surface of Lisbon is generally level, the south part being the most uneven. The calciferous sandrock appears near the centre of the town, and its dip is here nearly east. It is, as usual, filled with calcareous spar, and contains the earthy looking material which is often taken for oxide of iron. It contains the Orthis and broken columns of encrinites, and has a resemblance to some of the strata at Chazy. Upon its surface, fucoids are more or less common. The surface weathers to a drab color, as at other places.

This town contains an inexhaustible quantity of peat. A large morass or swamp, which runs through the south part, is one immense peat bog, extending over several thousand acres.

Madrid. The general features of this town do not vary essentially from those of Lisbon, but it is more sandy, and the subsoil is more argillaceous. One mile south-southwest from Waddington, the calciferous sandrock appears in place : its texture is coarse, and it is more gritty than usual ; color drab, or greyish brown. The layers contain calcareous spar, as usual. The strata are nearly horizontal, dipping only slightly to the east-southeast. The drab colored strata have been used with success for a hydraulic lime ; and they are also used as a building material, for which they are well adapted.

Several beds of peat have been discovered in this town : one near the half-way house between Columbia and Waddington ; another, about a mile from Waddington ; and another, half a mile from this place, on the road leading to Massena. Several more of small extent might be given, and most of the low wet grounds are in fact peat marshes. Upon the surface, the boulders are granite, hypersthene rock, sienite and limestone, in which are abundance of fossils of the trenton rock.

Louisville. The rock of this section appears at Redington's mills, on the De Grasse river : it dips northeast-north. It is fine grained, and of a dark color. Peat abounds in all the low grounds. Many of the morasses in which peat is so abundant, appear to have been swept out by currents of water, and their course is generally parallel with the St. Lawrence river.

Norfolk. At both villages in this town, calciferous sandstone rises above the surface, and at each place it forms the bed of the Racket river : it dips northeast-north. It also occurs three miles above Atwater falls, and continues uninterrupted to the falls. Bog ore is found in this place in considerable quantities.

Massena. The calciferous sandrock has been long used for lime, and large quantities are furnished to the British provinces for the public works. The color of the mass is a light drab. This variety possesses the same characters as that at Chazy, having a very compact structure or fine grain, and breaking with a conchoidal fracture. Dip northeast-north.

The boulders of Massena belong to the primary rocks and the trenton limestone, being similar to those already described as covering the surface at Hogansburgh, and which were supposed to have been brought from the vicinity of Montreal.

A hepatic spring, of some importance, has long been resorted to for the cure of cutaneous diseases. It is a few feet only above the level of the river ; rises from a bed of clay, and discharges nitrogen, or a gas which extinguishes flame. It contains in solution a highly deliquescent salt.

Stockholm. This town is upon higher ground than Massena or Norfolk. The surface rock is principally the potsdam sandstone. It is better adapted to agriculture than the preceding town. Peat exists, as in the neighboring towns, in the low grounds; but it is unnecessary to dwell upon the localities, or attempt to estimate the quantity.

Brasher. This town is traversed by three parallel ridges of sand and gravel, which run southeast and northwest, and the intervening spaces are level sandy plains. Tertiary clays underlie the sand beds, in which we find the Tellina grœnlandica. The beds of bog ore have already been described. Beds of peat are numerous and extensive.

Lawrence. The country in and about Lawrence is sandy. The rock is sandstone, but generally concealed beneath heavy beds of sand.

Hopkinton. Potsdam sandstone appears at the village. It is white, and dips southeast. This town, however, limits the sedimentary rocks in this direction. About one mile east of the village, a reddish granite crops out, and becomes the predominant rock.

TERTIARY OF ST. LAWRENCE.

The undisturbed beds of tertiary probably extend from the Gulf of St. Lawrence to Lake Ontario; not, however, in a continuous mass, but at intervals beds more or less perfect exist. At Ogdensburgh, the clays forming the banks of the river belong to this formation. Still farther northeast, as in Brasher, they occur with fossils. The sands which cover so much space in the northeast townships, and in Franklin, belong to this mass, at least in part. Without doubt, a portion of these sands originally belonged to the tertiary formation; but now, in consequence of having been swept from the original position in which they were deposited, they belong to the drift, or form a part of the boulder system.

The tertiary of the St. Lawrence cannot be fully described without farther examination. The fact that its banks are formed of this peculiar clay, is well known; but its depth, its extent and boundaries, cannot at present be clearly defined. The fossils of the clay at Ogdensburgh are in a decomposing state, and might be, and undoubtedly have been overlooked; but let any one examine these banks carefully, and he will not fail to find the Saxicava rugosa and Tellina grœnlandica. Clay occurs many miles also from the river, but whether it is to be placed in the tertiary, I am not able to determine. We know that clay is a common substance beneath sand; but because it is clay, it is no evidence in itself that it belongs to the tertiary beds. I am aware that many geologists rank most beds of this substance with the tertiary. But this mode of procedure does not appear to be warranted; and unless we can trace them continuously, or find some lithological characters (in the absence of fossils) which are constant, I do not understand on what ground they are placed in this class.

In regard to this formation in the northen part of New-York, we have evidence of its having been once continuous around the whole of its border. Thus, commencing at Whitehall, and passing round the entire northern border of the State to Ogdensburgh, this deposit was once

undoubtedly continuous; but at the present time, we find it only in separated beds: frequently the inferior beds remain, but more generally the upper are entirely removed.

Superficial Covering, Drift, or Boulder System of St. Lawrence.

The Boulder system or drift of this county differs in no respect from that of Franklin. It is, however, more favorably located for observation, as St. Lawrence has a larger territory than Franklin, and lies in a direction well formed to receive the floating materials from the north. The country slopes generally to the St. Lawrence river, in no part of the county steeply, but in by far the greater part very gradually.

The towns on the river, those which are underlaid by the calciferous sandrock, are low. Passing east from this to the sandstone of Potsdam, we ascend as it were from a lower terrace to a higher; and in going still farther east, from the potsdam sandstone to the primary, we reach a higher terrace still, and a portion of the county which is thrown more into hills and ridges; but still even in this part, for a wide space, there are but few steep and abrupt eminences. Upon all these terraces we find a thick mantle of sand, gravel and boulders, all of which belong to one era, or one system: it is the Drift or Boulder system. Now although the river towns are lower and more level, still they do not present a greater accumulation of these loose materials than the higher towns, and perhaps even not so great. This is contrary to what we should expect. The materials in the former or lower district, however, are all finer; that is, there is more sand and gravel, and it is spread more evenly over the surface. But there is a difference in another respect: there is more clay, which is frequently laid bare; and the loose materials, instead of having accumulated, have been apparently removed. Upon the sandstone region, the drift begins to accumulate, and we now find quite thick and heavy beds, and coarser too than in the limestone district. At the next step east, which brings us on to the primary, we begin to meet with large boulders imbedded in coarse gravel and sand. These beds lie in steep hills or ridges. In this arrangement, we find that it forms no exception to other parts of the district; for without exception, I believe, the coarse heavy materials have been transported to the higher levels, where they form stony rough ridges. The kind of boulders which prevail are those of granite and sandstone; the former are the transported rocks, and the latter appear to have been broken from the rock below. They are less rounded than the granite.

In the primary class we find also a few large boulders of hypersthene rock, particularly in the neighborhood of Ogdensburgh: generally they are not carried so far from the river as those of granite. These boulders may be traced northwards; they do not, therefore, appear to have been derived from the hypersthene rock of Essex; for we do not find that they increase in that direction, but rather diminish. We, however, find them continuously in a line parallel with the river: it appears, therefore, that they came from that direction.

Comparing the northeast part of the county with the southwest, another difference is found to prevail. In the towns in the former direction, a great many boulders of limestone are found, some of which belong to the rock of the county: they are of the calciferous, but

among them are numerous boulders of the trenton also. This last rock does not exist here, and hence these trenton boulders have all been derived from some other source. This fact has been noticed before; but I state it again, for the purpose of saying that these boulders have all lodged upon the north or northeastern slope of this county, and do not appear to have been transported farther south. We find them every where among the rocks of the county, mixed with travellers from a distance; the rocks beneath have been broken, and their fragments strewed upon the surface. They have not been subjected to the wear that those from a distance have. All the facts which have been observed in this county coincide with those which have been observed elsewhere. The direction from which the drift came is unquestionably north or northeast. The boulders themselves tell this, and the marks or striæ upon the rocks over which they were forced, point in the corresponding direction.

The boulders of this region are never very large, compared with some in the southern part of the Second district, but they make up in number what is lacking in size.

From the preceding remarks, it will be seen that the surface rock of this part of the county has little or nothing to do with the soil; as this is made up mostly in some parts, and entirely in others, of drift. It cannot be expected that the rock under these circumstances can contribute to, or diminish, the fertility of the soil, or be in any way connected with the matter which it is composed of. The only way which the subjacent rocks can affect the agricultural character of a country thus situated, is by means of their structure or porosity, by which their relation to water is determined. The existence of an open jointed structure affects the permanence of water upon the surface: for there it finds a ready passage into the rock, and passes through some of its layers by infiltration, or flows over the surface of some of the strata until it finds an exit at some distant point. Where the rock is porous, or with open joints, the surface is liable to suffer from droughts; but on the contrary, where the rock is destitute of a jointed structure, and is from any cause impervious, it retains the water, and thereby renders the soil too wet. These are points of great interest to the agriculturist, and control the productiveness of the soil as well as its composition.

Simple Minerals.

The simple minerals which occur in this county in the form of rocks, are,

1. *Primary limestone*, or calcareous spar. Some of the interesting forms of this substance have been given under the head of Rossie lead mine. It occurs, however, in many places, and furnishes some of the same forms as at the mine. The ordinary limestone, however, when crystallized, often gives the dodecahedral prisms. Some of these solids are very large, particularly at the Belmont mine, where some have been taken out which weighed over a hundred pounds. Its colors are purple, straw-yellow and limpid. Fine transparent masses have been obtained from the Rossie mine, and also from Belmont.
2. *Rensselaerite*, in Fowler, Dekalb, Edwards, Russel and Gouverneur. In Canton and Hermon, it is crystallized.

3. *Serpentine.* Fowler, Pitcairn, Edwards, Gouverneur.
4. *Albite,* appears to form a constituent part of the white granite at Gouverneur. I found, in one instance, beautiful hemitrope crystals of this substance in the Coal-hill mine.
5. *Pyroxene,* occurs in fine crystals in Gouverneur.
6. *Scapolite,* is associated with the former, and with feldspar, in large crystals at the same locality also in the lead mine.
7. *Tourmaline.* Near Richville, this substance has been procured of a green color; at Dekalb, it is in fine crystals, some of which are dark brown inclining to green. Brown tourmaline is common in the primary limestone.
8. *Phosphate of lime.* Probably the finest crystals known have been procured at Rossie. The locality formerly resorted to in Gouverneur, is nearly exhausted.
9. *Quartz,* in the dodecahedral form, was quite abundant at Edwards. Most of the mines of specular oxide of iron furnish large quantities of implanted crystals.
10. *Specular oxide of iron.* In splendent crystals.
11. *Magnetic oxide.* Chamont.
12. *Hornblende,* in fine crystals, in Edwards. Fine tremolite occurs in the north part of Gouverneur.
13. *Sulphate of strontian,* var. termed *Celestine.* Coal-hill mine, Rossie, in fine blue crystals; at the Osborn marsh, Gouverneur. in radiated masses.
14. *Sulphate of barytes,* associated with the specular oxide of iron.
15. *Fluor spar,* in small quantities, in Gouverneur.
16. *Sulphuret of iron.* Coal-hill mine.
17. *Sulphuret of copper and iron.* Canton.
18. *Zircon.* Rossie, in fine brown translucent crystals, associated with hemitropic crystals of feldspar and phosphate of lime in primary limestone.
19. *Mica,* in fine six-sided tables, at Pope's mills in Edwards; copper-colored, in serpentine, Gouverneur.
20. *Sphene?* A brown mineral whose appearance is like sphene, but supposed to be different, in Rossie. This mineral, however, occurs well characterized in Gouverneur.

Recapitulation of the leading Facts in the Geology of St. Lawrence County.

1. In the Primary system, the great developments are calcareous, together with the remarkable blending of granite and gneiss with the calcareous mass. This peculiar formation is confined to the southwestern townships.

2. Connected with the preceding, are the numerous veins of specular iron ore, but which are more intimately related to the primary limestone and serpentine than granite.

3. The limestone forms the same aggregate with serpentine, as in Essex already described.

4. These rocks embrace the principal simple minerals.

5. In the southeastern townships, we find, as in Essex, a large development of the magnetic oxide of iron, which appears to be associated with hypersthene rock.

6. The sedimentary rocks embrace only the two lowest in the New-York system; the Pots-

dam sandstone, and the Calciferous sandrock; the latter forming a belt about ten miles wide on the St. Lawrence river, and the former another belt rather wider on the east.

7. The rocks of St. Lawrence appear to have been subjected to two general forces at two different eras: the first produced an uplift, which inclined the sedimentary rocks towards the west, northwest and southwest, and the second raised up and gave to the sedimentary rocks an eastern dip; the first gave elevation to the whole country, and the last was connected with the formation of the present channel of the St. Lawrence.

8. The arrangement of the drift was described as lying in three parallel zones: the first consisting of fine materials upon the Calciferous sandrock: the second coarser, upon the Potsdam sandstone; and the third, consisting of water-worn boulders, and coarse gravel in high banks, on the edge of the latter rock and the Primary system.

JEFFERSON COUNTY.

Rivers, Valleys, and Surface.

Few districts are so deeply marked, or so strongly grooved by diluvial action, as Jefferson county. It is true the grooved furrows come from the territory north; and though it is not strictly agreeable to fact to speak of them with reference alone to Jefferson, yet it is here that these furrowings become more deeply cut, so that none but the most careless observer can overlook them.

The two principal rivers of this county pursue each of them a devious and winding course, especially the Indian river, which, soon after entering this territory from the east, turns to the north, and continues in that direction about twelve miles, when it turns directly to the south-west for fifteen miles; it then makes another sharp turn to the north, which direction it holds for twenty miles, and then passes out of the district which is under our immediate consideration. The course of the Black river is more direct across the county; yet it makes a bold curve to the north, called the *Great bend*, and performing a circuit of thirty miles, it regains its west course, and falls into Hungry bay on Lake Ontario. Glancing at the smaller rivers, or rather creeks, as laid down upon the map, we see that their course is southwest, or parallel with the St. Lawrence river, and also with the extension of the bays of Lake Ontario.

For the courses of the rivers and creeks, and the direction of the large bays of the lake, some general cause must be ascribed, which operated in a period antecedent to the flowing of the present waters, and which may be considered as having shaped and carved the surface so deeply as to control, in a majority of cases, the present direction of the rivers and creeks of the whole county. To produce this result, I have to refer, in this as in several other instances, to two causes combined; namely, first, fracture of the surface; and secondly, these fractures were followed by water moving in strong currents, and at times bearing along the loose surface rocks, by which the fractures were both deepened and widened. Now all the valleys of the county, north of the Black river, give direction to small creeks, which are generally sluggish; and on either side these creeks are bounded by fractured rocks, perhaps not entirely continuous, but mainly so. Corresponding to the direction, both of the valleys and fractures, are the scorings upon the rocks; which, in many instances, not only appear scored and scratched, but worn deeply, or channelled out to the depth of five or six feet; not simply one channel, but a dozen or more lying in close proximity, and in parallel directions. In illustration of this particular, I have introduced the following cut, showing the present surface in and upon which this deep channelling has been executed:

90.

Sketch showing the Channelling of the Birdseye at Watertown.

The locality of this extremely interesting phenomenon is immediately west of Watertown, upon the banks of the Black river. The rock thus acted upon is the birdseye, a firm compact mass, whose layers are as solid as possible; and hence the cutting out of these deep furrows has been accomplished solely in a solid mass, unassisted by a shaly or loose porous structure.

The course of these channellings or furrows is southwest and northeast; they cross the present channel of the river obliquely, and appear upon the north as well as the south side. In the direction of these channellings, half a mile southwest, is the commencement of a deep marsh, which must also have been excavated by the operation of a similar cause. The effects, however, do not stop here: we may trace them to the lake shore, and see that the whole depth of the trenton limestone has been cut through from Watertown for a distance of ten miles.

The channellings described above are overlaid by drift and soil, in a hard compacted mass, forming at this place a high bank along the shores. By this bank alone, the river is directed and preserved in its present course; and should the bank be removed, I see no obstacle to prevent the river from flowing direct to Sacket's-Harbor, or rather in the direction of Henderson, at the southern extremity of Hungry bay. From the Great bend, this direction is the one pursued to a point four miles above Watertown; there the strong rocky barriers of the trenton limestone intervene, and turn the river across these ancient groovings, until it has passed Brownville, where it falls into another still deeper and wider furrow, in which it flows to the lake.

The small uplifts in this county, in addition to the effects already spoken of, have produced a slight anticlinal axis, which traverses the county from a point half way between French creek and Cape Vincent, nearly east and west across the county. It does not, however, disturb the face of the country, and would be unsuspected without an examination of the present water courses. The effect has not been sufficient to overbalance the combined effect of the northeast fractures, and the currents which have swept through them. Some of the most distinctly marked valleys are the following: 1st, from Chamont, passing through Depauville to Lafargeville, a distance of twenty miles; 2d, from Watertown towards Evans' mills, on a line with the deep channellings already described. Three or four others, of less length and importance, on the north side of Black river, I pass by unnoticed.

Southwest of the river, extending up from Henderson towards Watertown, is another produced by the operation of the same class of causes already adverted to.

In pursuing our examination in the southern townships, we observe the same arrangement or direction of the rivers; but some doubts necessarily arise, when we examine critically the rocks and all the conditions of the surface. Probably, however, some of these causes have influenced the direction of the southern creeks, in order to give them a course parallel to those already noticed; but these creeks have, for a large portion of their distance, cut at least apparently their own channels. Rising in the highest ground, both geographically and geologically, in the fragile slates and shales of Loraine, Rodman, and the adjacent part of the county of Lewis, they have formed deep narrow gorges, in which they flow for the first twenty miles of their route to Lake Ontario. At their egress from these gorges, they have also worn into the trenton limestone a few feet; but when we compare the phenomena presented by these gorges, with the wider and shallower valleys north of Black river, we see that the latter are recent, and that they must have been formed principally by the present creeks which flow through them.

Instead of confining our views to Jefferson county, we may extend them to the corresponding part of St. Lawrence, or rather from the foot of Lake Ontario to the head of Lake St. Francis, a distance of one hundred miles. In this distance, taking in a breadth of fifteen miles upon the east side of the St. Lawrence, we discover the whole of this area of fifteen hundred square miles, channelled and grooved in the same manner as the parts of Jefferson which have been under consideration. We may look first at the direction of the rivers: they all fall into channels determined by previous fractures. The fact that in Jefferson they run southwest, is a matter of no consequence; the anticlinal ridge is so slight that the fractures cross it, or are continued through it from both sides. We may look at the lakes; we see that their longer axes lie parallel to the valleys already described. We may regard them all in the same light that we do Lake St. Francis — merely an expansion of the St. Lawrence; so the smaller lakes are only deeper and wider channels of the creeks and rivers which flow through; such channels, from causes not well determined, having been more deeply as well as more widely excavated.

From the interior of the counties, the rivers flow in direct or nearly direct courses, governed in their general direction by the general slope of the country through which they pass; but on reaching the district of the sedimentary rocks, they meet with a series of longitudinal fractures which govern the remainder of their route. What other cause could produce such a parallelism in all the rivers and creeks; in those, for instance, which carry a quantity of water insufficient to break over the small or low barriers between which they flow? The larger streams, from the same cause, pursue the most devious paths possible; flowing, during a part of their course, in channels previously marked out for them; but, in consequence of carrying a large amount of water, they sweep across these low barriers, and pass, in the course of their route, through several of the intervening valleys. The great bends in the Indian, Oswegatchie and Black rivers, and the curvatures of the De Grasse, Racket and St. Regis rivers to the north, are all produced by like causes. In these remarks, I leave out of view the channels of the St. Lawrence, as I propose hereafter to treat of the subject in a more general view, when the facts and hypotheses in relation thereto will be given in full detail.

In the preceding section of my remarks, I pursued a course different from that which I had marked out, yet I deem it inexpedient to return to the plan I at first proposed. I shall therefore merely add, that my great object was to describe the surface of Jefferson county so as to present in a true light some of the changes which its present surface has undergone. This has been done only generally; but a glance at the map will be sufficient, in connection with these remarks, to satisfy the most skeptical that they are founded in fact. Undoubtedly many interesting facts bearing upon this subject will be furnished from numerous localities, when the attention of observers is drawn to the subject.

Division of the county according to its rocks; their succession, and the peculiar features resulting therefrom.

There is a beautiful arrangement of the rocks of this county, such as very rarely exists: Here the New-York system commences, on the borders of St. Lawrence county, and the succession continues uninterrupted from the Potsdam sandstone up to the base of the Carboniferous system. It is here we find that gentle inclination of the rocky masses to the south, which, fortunately for science, is unbroken and undisturbed for two hundred miles, or at least never so much so as to obscure in a material degree the order of succession.

Of the entire series which enter into the New-York system, Jefferson takes in but a single group, which group is made up of the following members, namely, the Potsdam sandstone, Calciferous sandrock, Birdseye limestone, Marble of Isle La Motte, Trenton limestone, Utica slate, Loraine shales, and the Grey sandstone.

The order of succession of these several masses is as follows: Upon the north, the Potsdam sandstone extends four miles south of Theresa falls, where it is succeeded by the Calciferous sandrock and the Birdseye limestone in their usual order, whose southern limit may be defined by a line drawn from Carthage to Brownville. From thence the Trenton

limestone extends ten miles, to or near Tylerville in Rutland, and about twenty in the direction of Adams. A curved line extending from Adams to about two miles north of Tylerville, marks the southern boundary of the trenton, which is succeeded by the Utica slate in a very narrow belt, probably not more than two miles wide. This last rock is succeeded by the Loraine shales, which forms the surface rock of Rodman, Loraine and Pinckney in Lewis county. The Grey sandstone, upon the extreme borders of Loraine, is but an insignificant mass in this county, though it is largely developed only a few miles south.

The shales of Loraine extend west to near Mannsville, but do not approach Lake Ontario nearer than eight miles in this county; they have, therefore, quite a circular border, with the convex edge turned to the north and west. The Utica slate presents the same curved edges, but it barely crops out from beneath the upper rocks. The Trenton limestone, being a firmer rock, in fact more so in this county than in Clinton, extends as far as the Black river, which it approaches in a high bluff about four miles east of Watertown; from thence it forms the banks of the river to Watertown, where, immediately west of the village, it disappears in consequence of a fracture, and the birdseye becomes the surface rock to Brownville. From Watertown, the line of junction between these rocks runs in the direction of Henderson.

The lake shore in the west part of Ellisburgh is formed by thick beds of white sand, which conceals the rocks beneath. Whether the trenton limestone which appears near Ellisburgh, dips beneath the sand and lake, or is broken up as in many other parts of the county, is not clear.

At the present time, it is impossible to determine the former extent of the rocks of this county. We see that though they lie in nearly horizontal positions, still they have suffered from abrasion. We may conceive that each rock, whose general boundaries have been given, may have been extended much farther than we now find them. They all present broken edges at the north, with thick beds remaining, which is not the form they possessed when first deposited.

The principal feature which results from this arrangement, is, that a series of steps are formed, by which we ascend from the lower to the higher rocks in a regular gradation. The first step is from the potsdam sandstone to the birdseye limestone; the second from the birdseye to the trenton limestone, for the mass of black marble beneath the trenton scarcely crops out; from the trenton we pass to the utica slate, which forms only a narrow platform; and from the latter, to the loraine shales.

The middle part of the county is occupied by the birdseye and trenton limestones. The height attained in going up the whole series is probably six hundred feet. This by no means gives the whole thickness of the rock, in consequence of the dip south.

The above remarks may suffice for a description of the general arrangement of the surface rocks, and of their distribution, together with the peculiar features in the geology which results therefrom. The details in relation to each rock will be more precise and definite, which, together with the preceding, will furnish the reader with the main facts relating to the geology of Jefferson county.

General Remarks on the Primary and Sedimentary Rocks.

The details which I propose to lay before the reader, on the geology of Jefferson county, will embrace the principal facts relating to the formation and characters of the lower members of the New-York system. I have omitted till now those characters which are founded upon the presence of certain fossils, having hitherto contented myself with a description of the rocks by their lithological characters. I have pursued this course by reason of the imperfect development of these masses in the other counties, in consequence of which they did not furnish so good an opportunity to bring out the peculiar characters of the inferior rocks of this system as do those of this county. There is, however, one exception to this remark: In Clinton county, the lowest of the limestones are more perfectly developed than in Jefferson. I gave, therefore, in the article on Clinton county, several figures illustrating the palæontology of those lower limestones. My principal illustrations of this department in the geology of Jefferson, will begin with the birdseye limestone. The rocks of the lower series, however, are very well developed in this county, with the exception of the fossiliferous beds of the calciferous sandrock. One of the distinctive features of Jefferson is found in the great extent of the sedimentary rocks, or in the small extent of the primary ones. The northeast corner, consisting of an area of only a few square miles, and four or five narrow ridges of primary from St. Lawrence not extending south of the Black river, embraces the whole territory claimed by the Primary system. To these primary masses, require to be added some few miles of the same at Carthage and Alexandria bay. With these exceptions, the whole county is composed of sedimentary rocks, which extend from the potsdam sandstone to the loraine shales, comprehending all those masses which compose the Champlain group, described in general terms in the first part of this volume.

In the physical geography of Jefferson, we find but few prominent features. There are no high and commanding mountains, and the hills are all moderate; and so far as uplifts are concerned in producing an abrupt and broken country, we find none. Those parts of the county in which the hills form a prominent feature, are the highest geologically, and become so by a greater thickness in the deposition of sedimentary matter, and not by an elevation of the primary, as in most other instances in the Second district.

PRIMARY ROCKS OF JEFFERSON.

I shall commence with the inferior rocks, the platform upon which the sedimentary ones are deposited, and proceed from the inferior to the superior masses; following in this plan that order which nature has established, and which has hitherto been pursued in this report.

The primary rocks of this county are granite, primary limestone, gneiss and hornblende. I shall not attempt to define the limits of these rocks separately, but will speak of them as an entire whole, except in a few instances, where the peculiarities of a particular locality require a specific statement.

The first district where the primary composes the surface rocks, is at Carthage, and its vicinity on the eastern limit of the county. At this place, gneiss and granite extend about three miles upon the Black river, appearing in consequence of an uplift, which causes a succession of falls and rapids, known as the Long falls. To the north this mass extends four and a half miles on the Wilna road, and also in a northeast direction, or towards the Natural bridge in Lewis county. Sweeping around to the northeast, the north, and finally to the west, this mass of the primary forms the whole of the northeast corner of the county, and extends into St. Lawrence, where it is ten miles wide ; and as it proceeds northwest, it becomes still wider in that direction. Long, narrow, and apparently insulated belts of gneiss come down from the north, or from St. Lawrence county towards Evans' mills at the great bow on the Indian river, extending through Antwerp to the Oswegatchie. These belts of gneiss all terminate on the north side of this river, but their boundaries are never sufficiently defined to enable me to describe them. They alternate with ridges of potsdam sandstone ; the former occupying the low grounds and valleys, and the latter the ridges.

The gneiss of Carthage presents nothing which requires a particular notice : it is deep red ; feldspar predominates, and to this substance it owes its color. The gneiss, however, forms low ridges which trend to the northwest, and we find a succession of them on the Wilna road. The intervening spaces are low and swampy, from which there is a short abrupt rise to the summit of the ridge. About one mile from Carthage towards Wilna, the gneiss passes into an imperfect hypersthene rock, and also into hornblende and sienite. The gneiss of this section dips to the west and northwest.

Pursuing this mass of primary towards the Natural bridge, it still retains its distinctive features, but it is associated here with primary limestone.

In this region, though it is not elevated, we find a peculiar broken state of the surface, similar to what has been before described — sharp ridges of rock alternating with swamps, a condition which unfits the country for agricultural purposes. A large territory is thus constituted, forming a cold region, which will remain uninhabited for a long period yet to come.

The belts of gneiss which extend south from St. Lawrence into the great bend of the Indian river, and which continue west as far as Theresa falls, bear in general the same characters as the gneiss of Carthage. Primary limestone is often found beneath, where an uplift has elevated the masses forty or fifty feet. Its dip here is west or northwest ; and if we follow down the Indian river from the falls, we find a succession of low bluffs, some of which are gneiss, and others limestone. But six or eight miles below Theresa, in the vicinity of Muscolunge lake, this rock is somewhat changed. It has now become a mixture of grey granite intimately blended with primary limestone, the latter more frequently the inferior mass.

This compound forms a rock quite subject to decomposition. Wherever the limestone is exposed to the air, the whole mass disintegrates. Sometimes deep cavities are formed in the rock, which are constantly enlarging ; and if they are formed on the banks of a river or lake, and where water has access to them, the rock is gradually broken down ; and where cliffs are formed of this crumbling material, they are dangerous to examine.

It is in this compound rock that we often find several interesting mineral species. Thus the sulphate of barytes, several secondary forms of carbonate of lime, sulphuret of iron and copper, fluor spar, carbonate of strontian, are among the most common.

The last mass of gneiss which I shall notice in this county, is at Alexandria bay. It resembles that at Carthage, and passes into a hornblende rock, but in this mass we never find the primary limestone. From Alexandria it extends into the St. Lawrence river, and forms the base of the Thousand islands, with a few unimportant exceptions. Grindstone island, for instance, is composed in part of gneiss or primary, and partly of the potsdam sandstone. Very few minerals appear in this portion of the primary district: a few crystals of reddish feldspar, laminated masses of the oxide of iron in small cavities, crystals of black tourmaline, with a few others less important, comprise all which have been observed.

The masses of primary which have been described separately, probably belong to one continuous rock, upon which the potsdam and the succeeding limestones are deposited unconformably. The examination of these masses has produced the conviction, that wherever the primary is exposed, it has resulted from a removal of the upper rocks, leaving the inferior ones uncovered. This result originated from slight fractures and uplifts, by which the masses were more or less broken up, and brought into a condition in which they could be acted upon by certain physical forces, supposed to be currents of water bearing along hard bodies, as rocks and gravel embraced in masses of ice.

All the ranges of gneiss which traverse this county from north to south, fall short of one hundred and fifty feet above the level of the St. Lawrence, and are rarely over twenty or twenty-five above the adjacent low grounds.

In, or in connection with, the primary of Jefferson, few plutonic rocks make their appearance. At Theresa falls, dykes of white and greenish feldspar are intruded in the midst of a confused mass of serpentine, primary limestone and gneiss. Milky quartz is also abundant in seams at the same place; and though we do not usually place this among intruded or volcanic rocks, yet here it bears some of the characters which are possessed by them. We may, without doubt, attribute the origin of quartz frequently in primary rocks, to thermal springs which have ceased to exist.

Rensselaerite.

This rock is confined to the extreme northern border of the county, adjacent to St. Lawrence. It forms but in a few instances an extended mass, which is entitled to the character of a rock. As a mineral, it exists in crystals near the village of Oxbow in Antwerp, in the form of oblique rhombic prisms, and also in dark-colored radiating masses in limestone, and associated with serpentine.

Another locality of more importance, is near Butterfield lake, where it is in a large body. From this locality I have received a fine polished specimen which resembles the Italian marble; the ground is dark, nearly black, and it is traversed by thin tortuous viens of a yellowish color. The polished mass has a fine soft lustre, which imparts a beauty superior, if any

thing, to the Italian marbles. Of the locality, and of the character of the mass, whether it is adapted to economical purposes, I am unable to say. If it can be procured in large sound pieces, it is a very valuable material.

Iron Ores.

The ores of iron are confined to one species, the specular oxide. The magnetic, so far as my own observation extends, does not exist in the rocks of this county. The limited extent of those masses with which the iron ores are usually found, cuts off all expectation that they will ever form a very important item in the resources of this county.

Specular Oxide of Iron.

From the previous details of the geological structure of Jefferson, it will be seen that the area in which the primary ores of iron can be expected to occur is quite limited, and that they must, according to the facts and principles established by observation, be confined to the primary and the borders of the sandstone in the extreme north and northeast parts of the county. This we find to be true, so far as discoveries have been made, of the mines of the specular oxide in Jefferson. The following deposits only require a notice in this report.

Iron Ores of Theresa.

Within the circle of four or five miles of Theresa falls, we find several deposits of the specular oxide of iron. The first which I shall notice is known as the *Shirtleff bed.* It is four miles east of the falls. The ore is in the primary rock. The potsdam sandstone lies partially over the ore, and is deeply stained with the oxide. But the mass of ore lies below the sandstone; and though it is deeply reddened, and to the eye may appear sufficiently charged with iron to pass for an ore of it, yet, when examined, it is found a light lean mass, the body of which is wholly or mostly stone or rock. But on removing the mass of sandstone above, we find a layer of ore eighteen or twenty inches thick, which rests upon an uneven floor of serpentine. This is composed of the usual red oxide, without the crystalline structure which is often intermixed with this ore at other places.

This, however, is not esteemed a rich bed; and it is barely charged with a sufficient quantity of oxide to be received at the furnaces as lean ore, suitable to mix with the richer ores in quality of a flux. It yields from fifteen to twenty per cent., or about the same per centage as the ordinary bog ores.

Serpentine is the floor upon which this ore rests, in all that part which has been laid open and exposed. It is mixed with angular masses of grey quartz, giving the compound the appearance of a breccia. Some parts are hard and firm; others shaly, as at the Parish veins.

Two or three other veins, in addition to the Shirtleff mine, have been opened in the vicinity; but as they furnish only the same facts, I deem it unnecessary to give detailed descriptions of

them. Their geological position is the same, and they furnish identical facts with the other mines in this immediate neighborhood, and also with those of St. Lawrence county.

The Sterling Vein.

This is about three miles south of Somerville in Gouverneur. It is situated in low grounds, and covers a large superficial area. It is enclosed in gneiss; but within the workings we find the same associate of the ore, the brecciated serpentine; and here the imbedded quartz separates easily and distinctly, and under circumstances which favor the assumption that the latter mineral was actually inclosed or enveloped in the gneiss while this was in a pasty state. We have no means of determining satisfactorily the state and condition of serpentine previous to consolidation. A *state of mud* is often spoken of, and the phrase is supposed to express truly what it was; but the mud must have been composed differently from that of the sediment transported by rivers, which is abraded from rocks, and finally forms the slate and shaly rocks. But though the precise condition of this substance is not understood, yet very little doubt exists but that it was in a semi-fluid state, and was forced upwards through fissures in the superior rock. The masses of quartz in the serpentine at the Sterling mine, separate more perfectly than at the localities where I have noticed the aggregate. At some of these, it would scarcely be suspected that the two substances were ever independent of each other, and that the quartz was accidentally enveloped in the serpentine.

The characters of the ore at this mine differ in no material respect from those of the Parish and Kearney ores. It is principally the red mass, or the oxide in an earthy state. It is seated rather superficially, or near the surface, and seems to spread more widely than most mines of this description. The ore contains geodes of quartz, sulphuret and carbonate of iron, and calcareous spar. But a more interesting substance which is quite abundant here, resembles *Kakoxene*. It is golden yellow, and covers the surface of the ore in minute implanted crystals, principally occupying the seams.

Relations of the Potsdam Sandstone in Jefferson County.

Principal beds; limited area; fractured condition, etc.

The Potsdam sandstone, in some of its relations, resembles the primary; it is quite limited, and in many localities where it appears, it is in consequence of the removal of the succeeding mass.

This rock is confined to that part of the county which lies adjacent to St. Lawrence, and upon this border it forms the surface rock as far south as Evans' mills. Its southern boundary, however, is by no means formed by a straight east and west line; on the contrary, it is extremely irregular, and forms an indented border upon the south at its junction with the calciferous sandrock. To trace this border, or line of junction with the latter rock, we may commence about five miles southwest of French creek. From a point, then, at this distance

upon the river, the line of junction runs northeast, so as to pass about two miles north of Lafargeville; and when opposite this place, it turns south to the middle of Perch lake; at this point, it is nearly west of the great bend in the Indian river at Evans' mills. From Perch lake, it again runs northeast to a point four miles south of Theresa falls. This irregular curved line defines accurately the line of junction between the two rocks, for all that portion of the county west of Indian river. Now upon the east side within the great bend, the potsdam occupies the whole space, with the exception of that which is taken up by the primary. The calciferous only passes to the north side, just at the bend opposite the mills; occupying a small triangular space just within the bend of the river.

I have already remarked of the district enclosed by the great bend of the Indian river, that it consists of masses or ridges of sandstone, and bands of gneiss alternating with each other. In the lower lands, the gneiss is exposed in consequence of the removal of the sandstone, while the latter occupies principally the ridges. This disposition of the masses continues, with some slight and unimportant variations, to Lewis county upon the east. Connected with these beds of sandstone, is one which appears about three or four miles north of Carthage, on the Wilna road, which, for some distance, it passes over. This mass spreads out to the east into low grounds, in a territory which I did not particularly examine. Again, the road from Wilna to the Natural bridge passes over the potsdam, near the line of junction with the calciferous. On the road from Wilna to Leraysville, the sandstone appears in a small stream, about four miles distant from the former place. The whole rock is concealed, except where the drift and soil is deeply denuded.

I have now given the extent of this rock in Jefferson county; and though it is probably continuous over the area which I have attempted to define, still it is not possible to determine its presence under the great sand-plain which lies between Leraysville and Wilna or Carthage. There are several places, however, in the region occupied by the potsdam sandstone, which require a brief description. The first which I shall notice, is

The Sandstone at French creek.

This mass is laid bare for some distance, and the surface exposed consists of a yellowish brown sandstone, smoothed by the passage of drift. The deep grooves upon the surface, taken in connection with the extreme hardness of the rock, strongly favor the view that its surface was exposed to passage of drift for a long time.

Leaving the hard mass which underlies the village, and proceeding on the road to Depauville, we come to an uplift one mile east. The exposed rock is sandy and friable, and contains the Lingula antiqua. This small thin shell is preserved without mineralization, and the mass which contains it is perfectly arenaceous, and filled with dark brown patches, which appear like infiltrations of iron, though they may have been caused by the presence of animal or vegetable matter, which has combined with the ferruginous matter previously existing in the rock. This arenaceous mass lies immediately below the fucoidal layers, which indicate every

where the commencement of the calciferous sandrock ; and we find, on proceeding farther, that the calciferous soon becomes the predominant rock in this direction.

The Potsdam Sandstone of Theresa falls.

This rock is well exposed at the falls, by an uplift which discloses some interesting facts. At this place, the Indian river which comes from the south, falls about seventy feet over a ledge of gneiss, limestone and serpentine, into quite a large basin below, where it is nearly on a level with Black lake eighteen or twenty miles distant, and becomes boatable from the foot of the lake, with the exception of a few feet fall at two or three places in Rossie.

The uplift appears to have been caused at this place by the disruption of the primary limestone. Here we find some of the strongest evidences, not only of this fact, but also of the former condition and of the true character of the rock. The sandstone appears here in steep broken cliffs, and separated by masses of the primary. Under one of these fractured cliffs, a few rods east of the bridge and on the south side of the road leading east, the primary limestone is in contact with the potsdam sandstone, and here we may observe the changes which have taken place. Just at the line of junction, the sandstone is consolidated and vitreous ; the granules which compose the rock have lost their individuality, and are undistinguishable ; and while the rock has undergone this change, it has also become porous, or rather filled with small irregular cavities which have been occupied with spar. These cavities are confined to the vicinity of the limestone ; and a few feet above, it is in its ordinary state. There is evidently a change at the line of junction of the two rocks ; and from a combination of facts, I am satisfied with connecting them together as cause and effect ; and so long as no other cause than the limestone can be discovered, this connection appears not only rational but unavoidable.

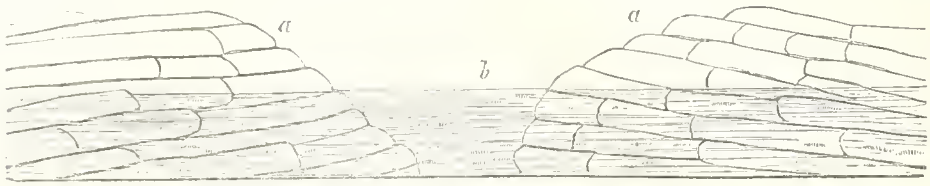
Passing from Theresa falls east, we shall find the arrangement of the rocks as described ; the potsdam alternating repeatedly with the primary, as in the following diagram, in which *a*, *a*, *a*, are sandstone ridges ; *b*, *b*, gneiss and hornblende ; *c*, *c*, clay, occupying the valleys. The section takes in about two miles, towards Theresa falls, from the Shirtleff ore bed.

91.

To the west, after leaving the falls, the potsdam sandstone is less disturbed, and we find it continues three or four miles. But in this direction we find one of the most common changes

which have happened to this rock, and as they are so common to this region, it is proper to describe them in this place. To illustrate clearly the points I wish, I refer the reader to fig. 92. The sandstone is, as I remarked before, but slightly disturbed, and it usually deviates

92.



a, a, Sandstone. *b*, Marsh, or low grounds.

only slightly from a horizontal position; but notwithstanding, we find it broken as represented in the cut, and the fractured edges present an appearance like a wall of mason work, extending sometimes several miles in a direct course. Usually at some distance east or west of one of these fractures, another wall runs parallel, or nearly so, and the space between the walls varies from a few rods to half a mile. Now it is probable that in all instances of this nature, the sandstone was continuous; and that by the operation of some cause or causes, the rock occupying the intervening space has been destroyed. The ground between such masses is always low and swampy, and indeed is often a deep marsh.

Another fact which is connected with the discovery of the cause of this state of the rocks, is the rounding of the broken edges of the strata as represented in the cut, bearing also the striæ which are common on the flat surface of rocks over which drift has been transported. Connected also with the above facts is another, viz. the direction of the strata coincides with that of the striæ upon their surface, which is north and south, or northeast and southwest. These phenomena all stand apparently connected together; but the particular inferences which may be drawn from them, I leave for others after having stated the facts.

Whether these fractures belong to the same class of phenomena which I have already described under the geology of Clinton county, some of which are called *gulfs* or *fissures*, I am not able to decide. In most if not all of the latter, rivers or creeks flow through them, and the fractured edges, I believe, are not rounded. The difference which may possibly exist is in their ages; those of Clinton being more recent, and like the gorges of Loraine, of which mention has been made, they belong to the later changes, or those produced by causes now in operation.

Calciferous Sandrock.

The Calciferous sandrock, though well developed in Jefferson county, is too much concealed beneath the birdseye limestone, to enable me to speak at much length of its characters. But this has become unimportant, since I have already given a full description of this rock. It occurs in place four miles south of Theresa falls, on the Watertown road. From this place it continues three miles, but most of the distance it is concealed beneath the soil.

But three or four uplifts in succession, varying from twenty-five to thirty-five feet in height, in which the different strata composing the rock appear, furnish an opportunity for an examination of a large portion of the rock. This mass, which succeeds the potsdam sandstone, continues the surface rock only one mile and a half, when it is succeeded by the birdseye. It dips generally to the south, and its principal natural joints run north and south, but the ranges of low hills of this portion of the county have a direction northeast and southwest. From this point, about four miles south of Theresa falls, the calciferous extends to the east and west; and taking the whole mass into view, it forms a belt traversing the entire width of the county, from near the Natural bridge on the east, to French creek on the west. This belt is from one and a half to four miles wide; its northern outcrop resting on the potsdam sandstone, while at the south it passes beneath the birdseye. Not far south from the first uplift which exposes the calciferous sandrock, on the road leading from Theresa to Watertown, the drab-colored layers form a large proportion of the mass. They contain masses of calcareous spar and sulphate of strontian, and disseminated particles of sulphuret of iron. These layers appear to be adapted to form the usual hydraulic lime. The portion of the calciferous exposed to inspection upon this road, is about sixty feet thick; and so far as my observations extended, it is destitute of fossils. The development of this rock in this county appears to be confined to the lower portion, or we do not discover those beds which, in other places, belong to the upper part. Some of them may exist concealed beneath the drift and soil.

The Calciferous sandrock, as it is exposed between French creek and Depauville.

On this route we traverse this rock from west to east. The first appearance is one and a half miles east of French creek, on the summit of a hill; it here succeeds the sandy variety of the potsdam, which has already been noticed. The fucoidal layers make their appearance first; they are very siliceous, and most of these vegetable forms are casts, and destitute of an organic structure. By far the largest portion have disappeared, leaving simply cylindrical but branching perforations in the rock. This mass is about ten feet thick.

Proceeding east, we soon reach the drab colored layers of the rock, quite similar to those already spoken of as existing on the Watertown road. Here they contain a greater amount of sulphate of strontian and calcareous spar. The rock continues to Depauville, where it is quarried for hydraulic lime. The lower strata at this place are evidently quite siliceous, or sandy. At Depauville the birdseye appears, but it only occupies the highest grounds. The union or junction of the two rocks is therefore formed at this place.

On a review of the characters of the calciferous sandrock, as it presents itself in the different portions of the Second district, we find that it is uniform in its composition and structure. Corresponding portions agree in most respects with those which have been noticed under the different counties. The fucoidal layers every where are the same, with the exception of a mass at Chazy, which being much more argillaceous than usual, may possibly be a distinct additional mass. The drab colored layers are specially uniform, being in all respects identical both in composition and color, and also destitute of fossils. When portions of this rock

are absent, they uniformly belong to the upper part. Such are the facts in regard to this rock in the northern district, where it is probably as fully developed as in the Mohawk valley, or in any other localities in this country.

Birdseye Limestone.

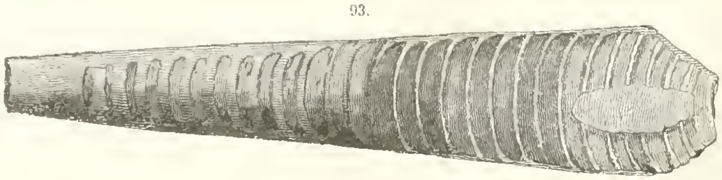
This rock forms a broad irregular belt through the whole county, from east to west. Its whole breadth is at least ten miles. Its northern outcrop, upon an east and west line, passes through Depauville, and a point two miles south of Evans' mills on the great bend of Indian river; from this point, it runs to the great bend on the Black river, and from thence to a point two miles southwest of Carthage. Its disappearance at the south, under the trenton limestone, is along a line extending from Champion nearly direct to Watertown. In this outline, I do not pretend to follow its windings; for on its outcrop, it will be perceived that in consequence of its having been exposed by denudation, it must necessarily present an indented rather than a straight edge to the north; and so on the south also, in consequence of the breaking up and wearing down of the trenton by which it is brought into view, the same irregular exposure will necessarily be the result.

The birdseye of Jefferson may be ranked among the thick-bedded rocks, some of the strata being at least two feet thick. Between the thick beds there are a few inches of shaly matter, in which we find a few fossils; but in general it is a compact rock, breaking with a conchoidal fracture, and weathering to an ash color. In this county, it is sufficient to remark, that it exhibits its usual characters, or those which have been given in the general account of the rocks of the Second district.

Along the Black river, the birdseye limestone appears to contain a greater number of fossils than elsewhere. Commonly the fossil called the *Fucoides demissus*, is the only one it contains; but here I have observed several, particularly a very large species of orthoceratite, often measuring eight inches in diameter at the base or largest part. Some are still larger, having a diameter of twelve inches, and a length of ten feet. In the upper part of the rock at the great bend on the Black river, the Cytherina is common, together with a species of the Calymene and Strophomena. But the remarkable compactness of the rock, and its slight weathering, make it almost impossible to procure perfect specimens even of parts of any fossil.

In addition to the large species of orthoceratite, I found one less than the ordinary size, which, from its frequent occurrence here and at a few localities in the Mohawk valley, must be considered as characteristic of this rock. It is the *Orthoceratites multicameratus* (Fig. 93).

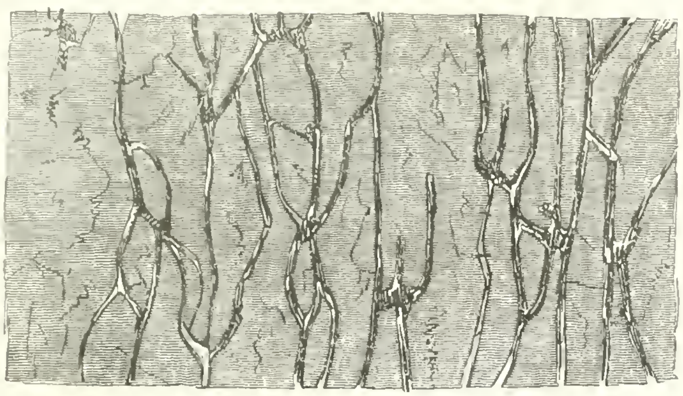
93.



It occurs towards the upper part of the rock, in the shaly layer, while the large one is enveloped in the thick compact strata.

But of all the fossils in the birdseye, the one called the *Fucoides demissus* is the most common and abundant. It penetrates the layers vertically; branching, or rather inosculating, in its own peculiar way, in the midst of the layer as well as upon its surface. It would seem that it chose its habitat far out in the deep, inasmuch as we find it always in the finest grained of all the limestone; its particles, from their nature, being well adapted to a distant transport from the shores. The annexed figure (94), represents the general arangement in the rock, and its peculiar inosculations.

94.



The drawing is a fac simile of this fossil, as it appears in a quarry at Fort-Plain in the valley of the Mohawk, except that it is upon a reduced scale.

The next figure (95), embraces a fragment of the fossil in its natural size.

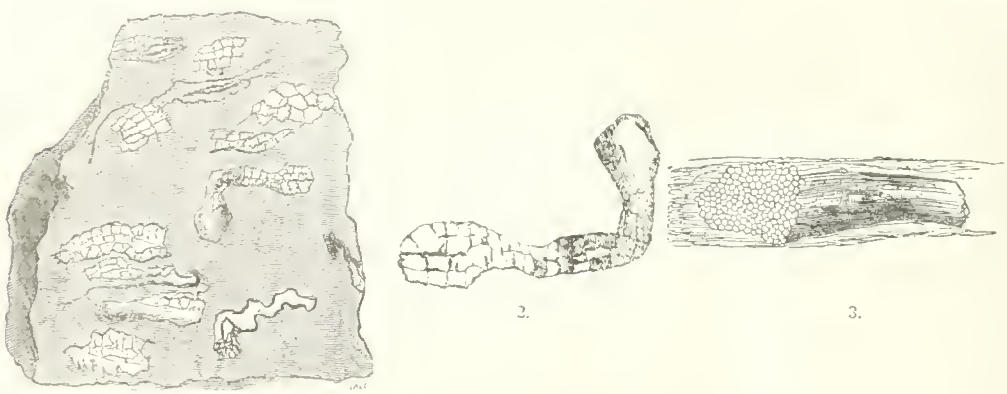
95.

It is taken from a specimen which is apparently charred or carbonized, and shows a tendency to a fibrous structure in the interior.

In the preceding figures, the organic structure is destroyed; and as it usually occurs, it is impossible to determine its nature. An imperfect fibrous structure, it is true, is brought out by weathering, but nothing appears sufficiently decisive to determine whether it belongs to the animal or vegetable kingdom. From the appearance and characters of species as usually found, it resembles a vegetable more than an animal; and hence Mr. Conrad, in describing it, placed it among the marine plants, in the order Fucoides.

Fortunately, on examining this rock in the valley of the Mohawk, in the vicinity of Fort-Plain, I discovered several specimens which clearly revealed the character of this fossil; and from these observations, it appears to belong to the family Polyparia. Upon the outside of the branches there is a thin covering, spreading apparently over the whole animal, which is perforated by pentagonal cells or pores, which communicate with thin longitudinal spaces or compartments. When the rock is weathered, if the surface is parallel to the length of an individual branch, it is partially fibrous; but if transverse, the surface is set with cruciform figures, as in the following cut:

96.



1. 2. 3.

Nos. 1 and 2 are representations of a surface which has been weathered transversely, so as to expose sections of the branches; and No. 3, is a representation of the outside, showing the pentagonal cells.

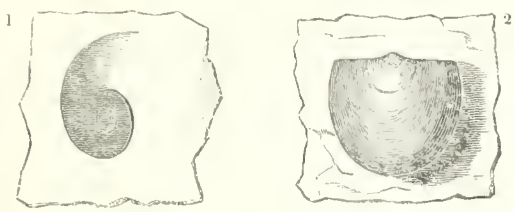
It appears from an examination of this subject, that since this fossil is enclosed in a very compact rock, which breaks always with a conchoidal fracture, it is impossible that it can be developed by breaking; and hence the only process which can develop it, is the natural weathering of the rock. But the external surface of the fossil is so thin, and the cells so fragile, that in most cases the whole organic structure, which alone can indicate the kingdom to which it belongs, is worn entirely off, or breaks down as the process proceeds, without

having the parts in relief. Hence only under the most favorable circumstances is the outside preserved, and this exhibits a structure which belongs only to animal forms.

I should not have occupied so much time and space with this fossil, were it not one of the most interesting in the whole animal kingdom, in its mode of growth, and in a variety of facts connected with its organization. It ceases to exist with the birdseye limestone ; and in some places in the Mohawk valley, particularly at Fort-Plain, it lives up to the trenton, but it ceases precisely at the line of junction between the two rocks. Not a branch or twig appears above the upper surface of the last stratum of the birdseye, and by no possible means could this fossil be discovered in a higher geological position. Upon the very last stratum, some of the most characteristic fossils of the trenton are deposited ; and from this platform, a new order of events take their rise, or a new series of beings date their beginning.

Of the crustacea belonging to this rock, a calymene appears to be quite common on the Black river, particularly at the Great bend. A figure of the tail of a species is given, in p. 276, No. 3. This is the only part which I succeeded in obtaining in any degree of perfection. Of the stone corals, one small cyathophyllum is met with, but it does not appear abundant. A bivalve shell, a strophomena, (Fig. 97, No. 2), is quite common at the Great bend. Of the univalves, one named by Mr. Conrad, *Ellipsolites* (No. 1), I have observed in

97.



1. Ellipsolites ? 2. Strophomena lævis.

several places. It is generally exposed by the weathering of the surface, but the structure is never brought out in sufficient perfection to show the entire form of the fossil.

Though this rock appears usually so meagre in fossils, yet a closer examination of it at numerous places will satisfy us that they are by no means wanting in it, but the peculiar structure of the rock forbids their exposure and detection in the ordinary way.

Descending from the village of Watertown to the west, along the whole mass of the trenton, and the *seven-foot tier*, as it is termed by quarrymen, we pass from these rocks successively to the birdseye. Each in its turn has been removed by abrasion, down to the latter, which forms the surface rock in the direction of Brownville to the lake, with the exception of a narrow ridge. At and below this village, the river flows through a deep rocky chasm formed of the birdseye.

The whole thickness of the birdseye in the county is not far from thirty feet. Neither at Watertown, nor at any point above, is it possible to determine its thickness. The river flows along within a chasm for some part of the distance after it enters upon this rock ; but as there

are no falls or uplifts of any magnitude, the whole thickness is nowhere exposed, unless at and below Brownville. Here it is slightly broken and elevated by an uplift, giving the mass a dip to the northeast and southwest, and forming an indistinct anticlinal axis. The force producing this uplift, elevated the whole mass higher upon the south than upon the north side. Just below Brownville, the drab colored layers belonging to the birdseye appear; and in one of the strata, I found the orthis which is so abundant at Chazy in the same position. In one of the strata above, cytherinæ in large individuals are not uncommon.

Isle La Motte Marble.

Resting upon the birdseye at the base of the cliffs at Watertown, is a mass of black limestone about eight feet thick. It is remarkably thick-bedded; in fact it appears to be one stratum, the divisional planes being exceedingly obscure. This is the same wherever this rock occurs. At Isle La Motte, where it is about twelve feet thick, it has been blasted through as if it were one continuous stratum.

At Watertown, this rock is broken, or seems to be formed of lumpy masses; such at least is the case wherever it has been exposed in the banks of the river, and in this respect it differs from the same rock at Glen's-Falls and Isle La Motte. It is black, fine grained, without shaly matter, but is disposed to break into irregular masses, and hence it appears unsuitable for the purposes for which it is so valuable at other places. It is here called the *Seven-foot tier*, and is quarried for walls, and a variety of purposes of a coarser description.

The character of this mass connects it rather with the birdseye than with the trenton limestone, between which two it lies. I have never observed the fossils of the trenton in it; but a columnaria, and one or two species of large orthoceratites occur in it. The combined facts in relation to this mass seem to indicate that it is the terminating mass of the limestones below the trenton, or that it is not the commencement of that order of things which succeed and follow in the latter rock. From its compactness, we find the fossils difficult to procure, and none of them in a state fit for illustration by figures, except the columnaria which has already been placed before the reader (p. 276, Fig. 73, No. 2).

The value of this stratum at other places in the Second district, encourages me to hope, that in the vicinity of Watertown, it may be found in a state suitable for marble. It forms for an inconsiderable extent the surface rock; it merely crops out beneath the trenton, without extending beyond it. The caves of Watertown appear to have been excavated in this mass, and they were probably formed at the same period as were all the other surface excavations. At a few points, the removal of this rock has caused the trenton to cave in, and form upon the surface depressions more or less conical.

Trenton Limestone.

In this county, this rock furnishes two quite distinct varieties: a compact black mass, and a grey crystalline one. The former is sometimes even-bedded, with masses of slate intervening; at others, it is uneven, irregular and lumpy, with the same quantity of slate as before investing the irregular masses. The grey variety occupies here the highest position, though it is by no means constant; or at least the lower dark colored and compact beds alternate in some localities with the grey crystalline mass, so that the latter is as often beneath as the former. This fact alone, therefore, prevents the division of this rock into two species; but if this were not the case, and if the grey mass occupied uniformly the superior position as in Jefferson, yet as the fossils in both masses are mostly the same, it would still be inexpedient to divide it and form two distinct rocks.

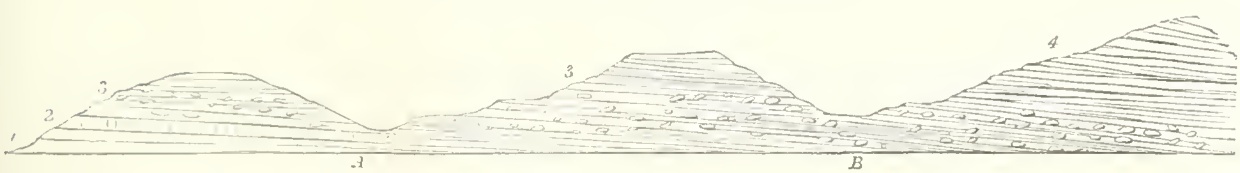
The trenton limestone rises from the Black river in a series of terraces to the south, though they are not uninterrupted. The first is in the form of a steep bluff from the river to the platform upon which the village of Watertown is built. This extends south half a mile, when it descends nearly to the level of the river; from this valley the rise is regular for two or three terraces, where it again descends into a deep valley whose bottom is not much higher than the river at the village. It then rises in rather steeper and less regular terraces, and forms the high range of limestone three and a half or four miles south of the village.

The structure and form of the terraces which rise and descend in succession as has been described, were not produced by uplifts, or by derangements in the strata in consequence of disturbances, but solely by the action of currents bearing along drift. The minor valleys thus cut out of the trenton extend in the direction of the Black river, and range more to the east than the valleys which have been described in the preceding pages.

For a farther explanation of this rock, and the changes which it has undergone, I have introduced the following section, which extends south from Watertown four miles, over the terraces herein described:

Section from Watertown four miles south.

98.



1. Birdseye forming the channel of the Black river.
2. Isle La Motte marble.
3, 3. Trenton limestone.
4. Grey crystalline variety.
A. First valley of denudation. B. Second valley of denudation, each of which extends northeast and southwest.

The terrace (No. 4) is covered with a thick mass of debris, which conceals the rock except in a few points. Boulders of all kinds have lodged upon this hill, while the valleys below are filled with sand.

The thickness of the trenton limestone at Watertown, including the whole mass which extends south, and which is embraced in the section, is about three hundred feet.

The natural joints as exposed on the northern outcrop, are N. 45° E. and S. 75° E. The former corresponds to the principal valleys of the county.

Having given those details in relation to the position and general character of this rock which seemed necessary, I shall now proceed and describe its boundaries. I shall commence at Champion, near which place I suppose this rock to come up from Denmark in the county of Lewis. From Champion, the trenton forms a curve sweeping round to the northwest in the form of a high commanding bluff, till it reaches the Black river about four miles east of Watertown. It forms, for the most of this distance, the steep rocky banks on the south side of the river. At Watertown, a small broken bluff appears upon the north side, but extends scarcely more than half a mile. From the south side of the river, the broken edge of the trenton may be traced southwest twelve miles, to or near the lake shore, and about six miles north of Henderson. It forms a part of the rocks near the shore at Henderson. From this place it runs directly south to Ellisburgh, in which direction it continues till it passes into the county of Oswego.

The southern boundary, or the line of junction between this rock and the utica slate or loraine shales, passes nearly northeast from Mannsville, in the direction of Adams, Whitesville and Tylerville. Between Adams and Tylerville, the utica slate crops out beneath the loraine shales, and forms a narrow curved belt, scarcely more than two miles in width.

The geographical position of the trenton, then, is south of the Black river, between Champion on the east and Hounsfield on the west, and Watertown on the north and Adams and Whitesville on the south. This forms the great body of the rock in Jefferson county. There are, however, several smaller patches which it is important to notice. Thus, after leaving the eminence upon which Watertown is built, and proceeding towards the west, we immediately pass from the trenton to the birdseye. This is, however, but a narrow belt, not over half a mile wide. After leaving the birdseye, we pass from it again to the trenton, about one mile below Watertown. The trenton at this point is merely a low narrow ridge, but it increases in width and height as it stretches away south; and where the road to Brownville crosses it, it is equal in height to the hill upon which Watertown stands. From this ridge of trenton limestone we pass again to the birdseye, when about one mile east of Brownville, whence the latter rock continues to Dexter on Black river bay. The range of trenton, then, lying between Watertown and Brownville, stretches away to Sacket's-Harbor, where it forms the shore of the lake.

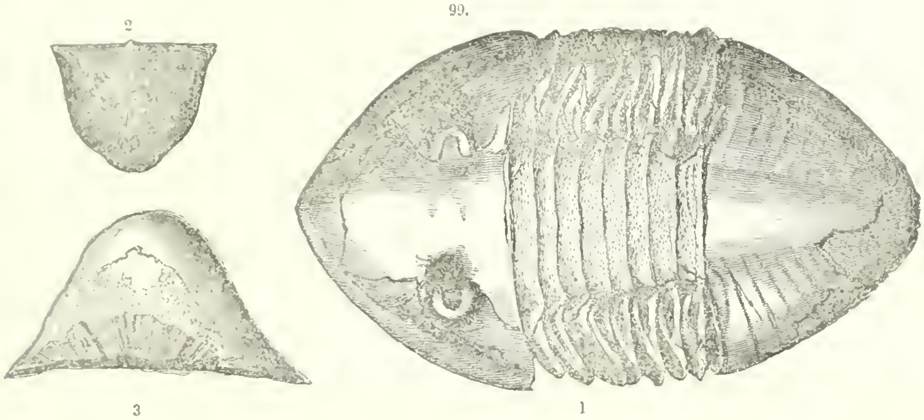
This mass of the trenton is therefore entirely insulated, or cut off from the great mass on the south side of the vein, and the cause of this separation has been detailed at some length. A mass just west of Watertown has been entirely cut out as far southwest as the lake, for the distance of ten miles, leaving on the west the ridge just described, which lies with its long axis to the northeast, coming to an apex about half a mile west of Watertown.

There are two other masses insulated much in the same way. Thus, crossing from the bay at Sacket's-Harbor, over to Pillar point, we again come upon the trenton, which extends over to the west side, or to Chamont bay. Here again the trenton is excavated deeply; and after crossing the neck of Chamont bay, we find the shores consisting of the trenton, as far as Cape Vincent.

From these remarks, the geographical extent of the trenton will be seen; and in the details, I have introduced those facts which relate to the causes which have controlled the present extent and limits of this rock, from which it appears that it has been considerably limited, especially in the part which extended north.

I shall now proceed to speak of the fossils which characterize the trenton limestone. And upon this subject I may remark, that few rocks are so finely distinguished as this; from the birdseye to the utica slate, it is not only well supplied with organic bodies, but they are limited to this mass, so far at least as it has been examined in New-York. Not one of the fossils of the trenton have been found in the limestones below, and as yet it is quite doubtful whether they appear higher in the utica slate or loraine shales. Those which first claim our attention are the crustaceans, some of which figure largely in the fossils of the trenton rock, being found in great numbers wherever it occurs.

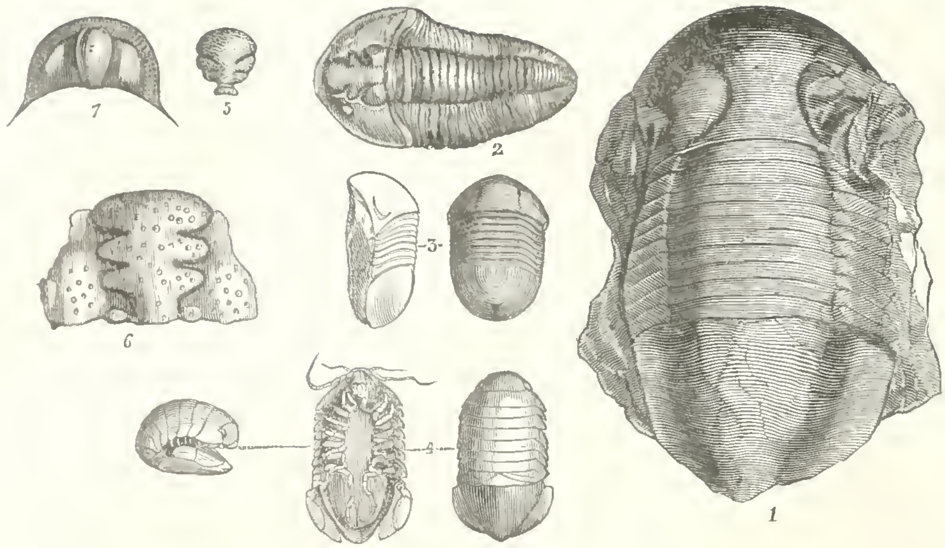
99.



1. Isotelus gigas. 2. Strophomena deltoidea. 3. Favosites lycopodites.

The Isotelus gigas (No. 1), is one of the most persistent fossils of this mass. It, however, happens generally, that it is only obtained in parts, the extremities being very liable to separate from the body. It may be found at Essex, Plattsburgh, Chazy, Glen's-Falls and Watertown. Some large individuals have been obtained near Glen's-Falls, and in the shaly limestone at Plattsburgh.

100.



1. Bumastus trentonensis.
2. Calymene senaria.
3. Illænus trentonensis.
4. Sphæroma bumastiformis (Eights).
5. Calymene.
6. Ceraurus pleurexanthemus.
7. Trinucleus tessellatus.

No. 1 has not been found in place; the fine specimen from which the drawing was made, was found by a laborer in Hogansburgh, in a boulder of black bituminous limestone. The boulder is identical with the black limestone of Montreal, which contains the Trenton fossils. Upon the fragment containing the specimen, is discoverable a portion of a strophomena, known also to belong to this rock; there can be no doubt, therefore, of the position which it occupies. But usually where a fossil has been obtained from a boulder, no account has been taken of it. No. 1 is allied both to Bumastus and Isotelus, or seems to be an intermediate genus: it is probably a rare fossil.

No. 2. The *Calymene senaria* is one of the most abundant fossils in this rock. In the Second district, it is found at Glen's-Falls, Essex and Plattsburgh; and it is also found at Cumberland Head, or the opposite shore in Vermont, where the slaty limestone of the trenton rock is found. In some places, as at Essex, it seems to have congregated in immense numbers: nearly a hundred heads, in an imperfect state, were observed upon one orthoceratite. This species has generally been mistaken for the *Calymene blumenbachii*, which belongs to rocks higher in the series.

No. 3. For this small trilobite, I am indebted to my friend, Dr. Crawe, of Watertown. It seems to be rather rare, though it has been found in the valley of the Mohawk. The specimen from which the drawing was taken, was found at Watertown.

No. 5, is a portion of the head of a calymene, merely the central part. It is given in the state and form in which it is usually found; hence it serves, even in this condition, to characterize the rock.

No. 6. *Ceraurus pleurexanthemus.* This is more rare than the preceding; and from its strong resemblance to a calymene, I have doubted whether the description given by the Palæontologist of the Survey may not require some modification. Whether this may be so or not, being a trenton fossil, it will serve the purpose for which it is introduced. The figure represents merely the head, the other portions being rarely found.

No. 7. *Trinucleus tessellatus.* (*Cryptolithus,* Green), is another crustacean extremely abundant in some localities; thus, multitudes may be procured from the limestone near Glen's-Falls. I did not observe it at Essex, Plattsburgh or Chazy. There seems to be the same relation in the distribution of fossils, as in that of animals at the present day. They are accumulated in localities which were favorable to their habits when living. Hence, though a fossil may be confined in its range to a single formation — a rock, yet it does not follow that it will be found in every location of that rock. In many instances, great multitudes of the crustaceans herded together, having the instinct of sociality; though the fact may have arisen from the favorable conditions of the location, the supply of food, concealment, protection from violent currents and uncongenial temperatures, together with the various other considerations which influence animal life.

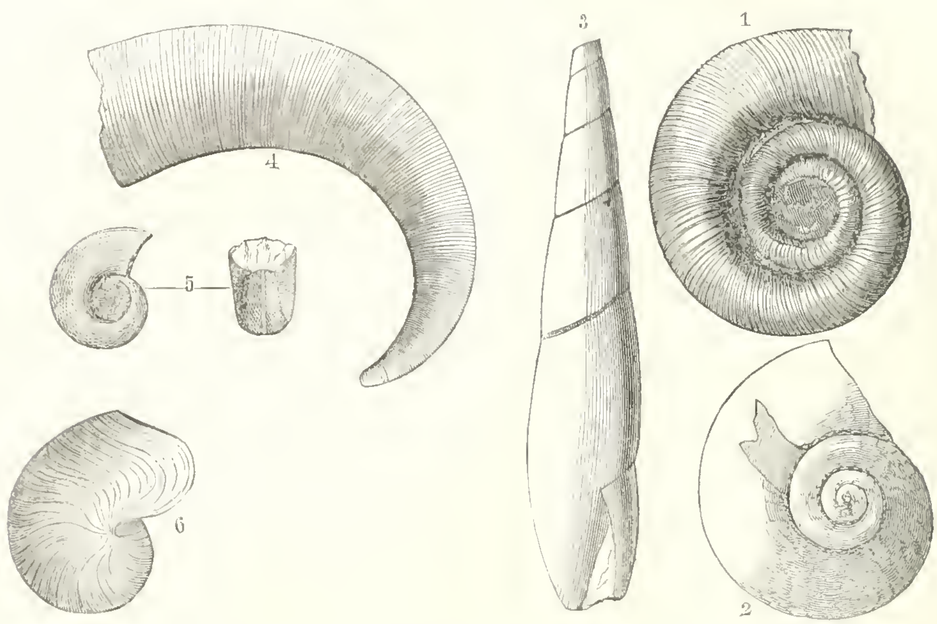
No. 4. I have introduced three figures of a recent crustacean, for the purpose of illustrating the preceding fossils. I have placed them side by side with those ancient ones which abounded so much in the Trenton era, and which, if we may place reliance upon the faithful observations of hundreds of geologists, whose efforts have been directed for years to this subject, are proved to have become extinct with that era, as none of the same beings appear above the Champlain group. It is obtained from pools left by the receding tides along the shores of Cape Horn. This small crustacean appears closely allied to No. 3 of Fig. 100. From the observations of Dr. Eights, to whom I am indebted for the specimens, both species have the same habit of bending their bodies, and bringing their extremities into contact, in which position they are always found when left by the tide. Indeed, it appears that most of the genera of fossil crustaceans indulged in this habit, as we often find them thus coiled or bent. The texture, too, of the superior plates of the body and extremities, is as similar as possible to the petrifactions of the trilobites. We never find but a very small part of the inferior surface of the fossils of which I am speaking, so that many facts in relation to them remain unexplained; their mode of progression and of rest; whether they adhered to bodies by suction or by legs, etc. On these points, it is barely possible that discoveries hereafter may throw some light. It is probable that the inferior surface was uneven, and that the matter in which they are enveloped adheres in such a manner that it is impossible it should be detached so much as to show the inferior structure. Now we see that this recent trilobite has only feeble legs, short and obscure; and hence if an animal thus constructed were to be imbedded in mud, and subsequently consolidated, there would be a very small chance of

so detaching the stony matter from the inferior surface, as to show its legs, or the divisions of its abdomen.

From all the facts which have been disclosed in relation to these animals, I see no objection to placing them in one family, and considering the recent crustacean which I have figured as a representative of the ancient race. Some difference in organization may be found, yet the general form and some of the habits are so nearly alike, that in considering them all as one family, our error will be but trifling. In conclusion, I would remark that one important duty yet remains for geologists and naturalists, namely, to compare, more carefully than they have yet done, fossil with living bodies.

Having stated the principal facts in relation to the localities of the crustaceans of the Trenton period, I shall now introduce the following cuts illustrative of the univalves which have been discovered in this rock.

101.



1. Trocholites ammonius. 2. Pleurotomaria lenticularis. 3. Subulites elongata. 4. Cyrtoceras filosum. 5. Bellerophon punctifrons. 6. Bellerophon bilobatus.

No. 1, is a rare fossil in the trenton; it has been found in the Mohawk valley, but it has not fallen under my notice in the Second district.

No. 2, is quite abundant at Watertown, and is common in the sub-crystalline grey variety of this rock. This is a large individual.

Nos. 2 and 3 (fig. 102, p. 393), are the same species, and are drawn of the usual size of the animal.

No. 3, is not uncommon in the sub-crystalline grey limestone of Watertown. The fossil was furnished by Dr. Crawe, to whom I am indebted for many similar favors.

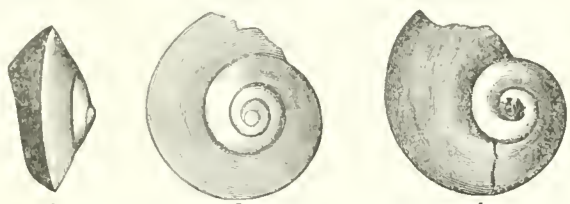
No. 4. This is the only specimen which I have seen of this fossil.

No. 5, is a beautiful bellerophon of Watertown, in the same crystalline limestone.

No. 6. *Bellerophon bilobatus.* If this is the same fossil figured by Mr. Murchison in the Silurian System, it furnishes an instance of a wider range than is possessed by the Trenton fossils generally. It is not clear that it is the same, but the resemblance is so close that it seems inexpedient to give it a new name. The fact that it occurs so far below the bilobatus, is presumptive evidence that it may be different. This species is common at Watertown, and it has been discovered by myself in Crown-Point, near the fortification.

In all the older rocks, some difficulty is experienced in obtaining the important parts of the fossils in a state sufficiently whole to enable the palæontologist to decide upon the question of identity. In most instances, for example, the form of the mouth is lost in consequence of the fracture of the lip.

102.



3 2 1

Nos. 2. and 3. *Pleurotomaria lenticularis*, already referred to. The drawings preserve the character of the fossil more perfectly than in No. 2 (fig. 101).

No. 1. *Pleurotomaria* ——, is common at Watertown, in the grey variety of the trenton limestone.

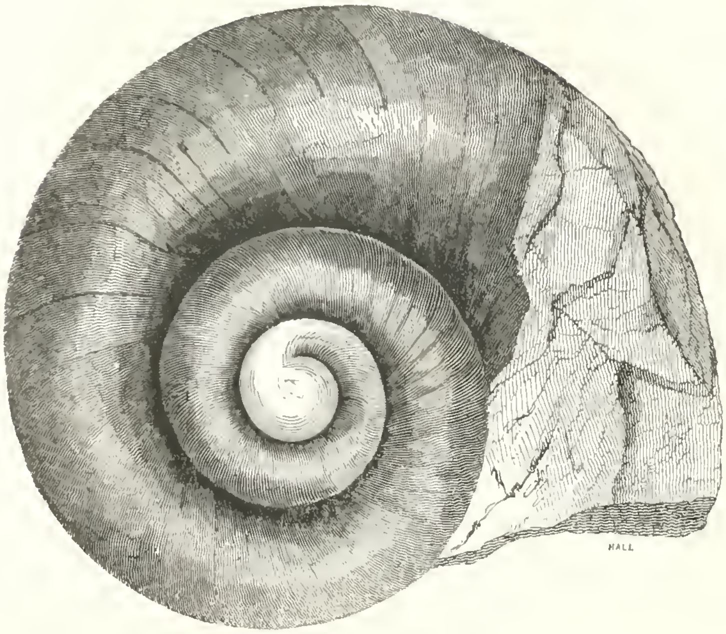
103.

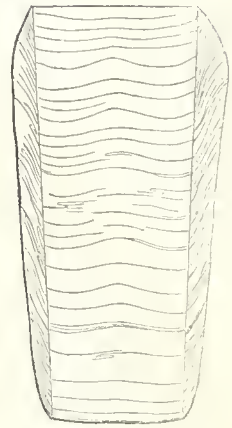
3 2 1

Nos. 1, 2, 3. *Bellerophon profundus*, is abundant in the black variety of the trenton. It is found upon the banks of the river at Watertown, in the lumpy variety of this rock. It may be obtained from certain irregular masses which no one would suspect to contain fossils; the masses are black, smooth and polished, and exhibit no external markings. This fossil is sometimes found of a size three or four times larger than in the above drawings, which is that of the individuals discovered in this locality. In none of these small specimens was I able to obtain

the mouth; but in a single and much larger specimen, it appeared that the mouth was remarkably expanded and wide, so much so as to be apparently out of proportion to the rest of the animal.

104.





1. Inachus undatus. 2, edge view.

This remarkable fossil is found at Watertown, in the black limestone. It is rare. Casts sometimes occur which are smooth.

The following bivalves may be considered as characteristic of the Trenton limestone:

105.

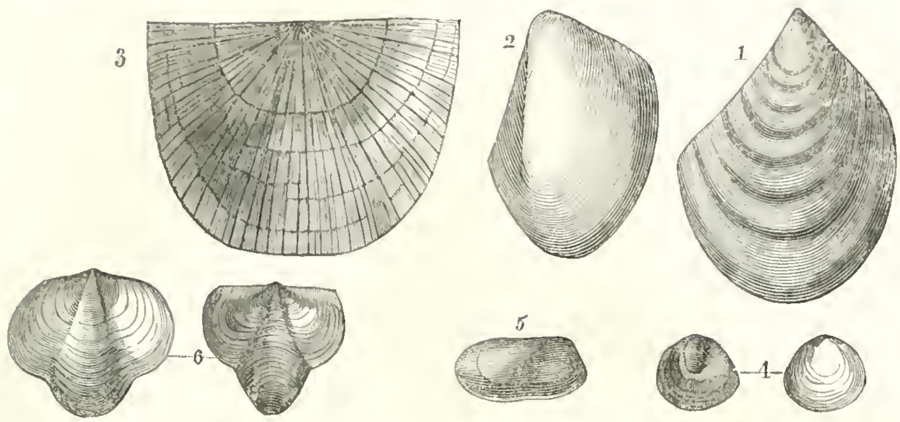
1 2 3

1. Strophomena sericea. 2. Orthis pectinella. 3. Orthis striatula.

Nos. 1 and 2, but more particularly the latter, abound at numerous localities in this county.

No. 3. This is probably as constant at all the localities in the trenton rock which have been examined, as any fossil which I have hitherto observed.

106.



1. Pterinea undata.
2. Nuculites inflata.
3. Strophomena alternata.
4. Orbicula terminalis.
5. Nuculites faba.
6. Atrypa extans.

No. 1. *Pterinea undata*, is a rare species, found in the grey variety of the trenton at Watertown.

No. 2. *Nuculites inflata*, is also a rare species, found at Watertown. The trenton is the lowest rock in which the genus Pterinea has yet been discovered ; a fact which is interesting, inasmuch as this genus furnishes so many species in the rocks of the New-York System.

No. 3. *Strophomena alternata*, whose striæ or markings are alternately fine and coarse. This character is possessed, however, by other species, and hence is not in itself to be relied upon as specific.

No. 4. *Orbicula terminalis*, is a new species, in the grey trenton at Watertown. Both valves are preserved in the specimen from which the drawing was made. It is rare ; only one specimen has fallen under my notice.

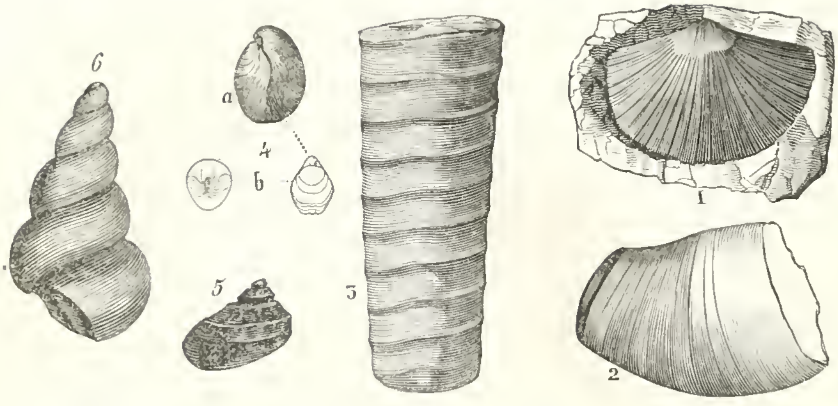
No. 5. *Nuculites faba*. This fossil is very abundant at Watertown, in the black irregular-bedded limestone.

No. 6. *Atrypa extans*, is found at Watertown in the grey limestone, and, at this locality, appears to be sufficiently common. I have not, however, seen it elsewhere.

The Pterinea orbicularis (No. 3, Fig. 109), is found at Watertown, in the black limestone, associated with Nuculites and Bellerophon profundus. Though quite common here, it is rare to obtain it perfect, as the shell is thin.

The corallines of the trenton limestone consist of several known genera, each comprising but a few species. No. 3 (Fig. 99, p. 389), represents the *Puffball favosite*, which is probably as characteristic of this rock as any of which mention has been made. It is found at Essex, Plattsburgh, Chazy, Watertown ; in fine, there is no locality of this rock which has not furnished numerous specimens of this fossil.

107.



1. Orthis leptænoides.
2. Orthoceratites trentonensis.
3. Orthoceratite.
4. Orthis bisulcata.
5. Pleurotomaria.
6. Pleurotomaria.

No. 1. *Orthis leptænoides*, belongs to the grey variety of the trenton rock; but judging from the small number yet found, it ought to be set down as rare.

No. 2. *Orthoceratites trentonensis*, is common; and what is rather singular, we meet only with this portion of a part which is slightly curved.

No. 3. *Orthoceratite*, is also common, and belongs to the grey variety of the limestone.

No. 4. *Orthis bisulcata*, is one of the smallest of this genus which has been seen in the trenton rock. It was found in Adams, where it is quite common. *b*, natural size; *a*, enlarged.

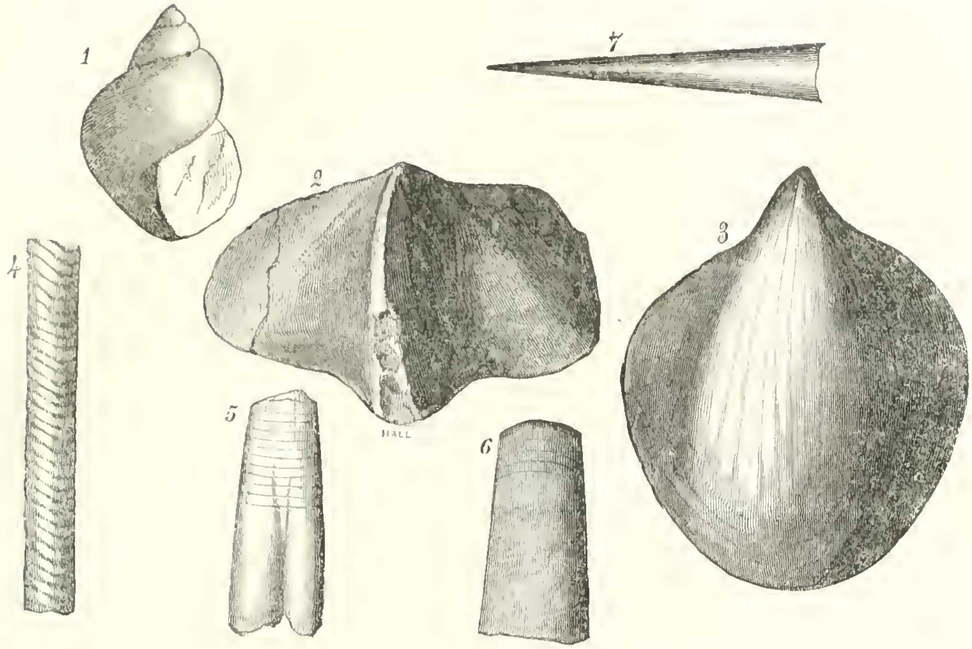
Nos. 5 and 6. Both species are quite common; the first is found in the black limestone at Watertown; the other in the grey, south of the village, and has a wide distribution. I observed it more or less perfect at all the localities which were examined. It is, however, always a cast, and I have never been able to procure the fossil entire. In stating the position in which the fossil has been found, it is not for the purpose of conveying an impression that the two varieties are distinct masses. The fossils will not be found confined to either; and furthermore, they alternate with each other. Still, in several instances, so far as observations have been made, some fossils appear more abundant in one than in the other. The black variety is a limestone less pure than the grey: it is generally interlaminated with shale, and hence its composition is adapted to some species of animals, and much less so to others; and so also the same remark applies to the grey limestone.

108.

The *Delthyris* —— occurs in the grey limestone at Watertown, and the *Delthyris expansus* (No. 2, Fig. 109) is associated with it; they are obtained only in casts, and both are rare.

The trenton appears once more to limit a genus, so far as the rocks of the northern district are concerned: this genus does not occur below. There are some unexplored places where it is possible the Delthyris and the Pterinea may be discovered. I refer to the upper part of the calciferous sandrock, which has furnished already several new species.

109.



1. Pleurotomaria. 2. Delthyris expansus. 3. Pterinea orbicularis. 4. Cameroceras trentonensis (siphuncle).
5. Orthoceratites. 6. Orthoceratites. 7. Orthoceratites multilineatus.

The orthoceratites are among the oldest genera of the animal kingdom. I observed in the calciferous one large species, but it may be considered rare in this rock. In the birdseye, however, as has been observed, they are among some of the largest fossil bodies of the kind. In the trenton, the individuals of some species are quite numerous, but no more so than in former or subsequent periods in the New-York rocks.

Utica Slate.

It is a remarkable fact, that this rock, which succeeds the trenton limestone, and which is lithologically constituted like the slaty part of the trenton, should still, among its most important characters, possess those which are so diverse. The facts in these respects will appear in the subsequent pages.

I have already had occasion to remark, that this rock is quite limited in this county, notwithstanding it is well developed. Its outcrop may be traced from near Adams, in a curvilinear line, to two miles north of Whitesville and Tylerville, where it passes round eastwardly beyond the limit of Jefferson. The belt or area exposed is rarely more than two or three miles wide. Towards the southwest, it disappears beneath the loraine shales. It is also exposed in the great gorges in Rodman and Loraine, the great mass of shales being cut through by the sandy creeks.

This rock is very fragile, and never sufficiently firm for roofing slate. It decomposes rapidly, and hence the surface which it underlies is always rounded or rolling. When moistened or wetted after removal from the bed, it breaks or cracks to pieces; and hence, we find that wherever streams pass over this rock, they invariably cut deeply into it, and form gorges. It is more owing to this cause that the streams produce so much effect in forming channels in the rock, than to their mechanical action. For we find the rock constantly breaking down simply by drying after a rain; and especially by the absorption of water between its layers, and subsequently freezing, the mass is still more rapidly broke down into earth or an argillaceous soil.

The color of this rock is black, but by exposure the outside becomes grey. The mass is essentially argillaceous, and rarely if ever shaly or sandy. It differs in this particular from the argillaceous strata of Loraine. It has natural joints, or rather a crystalline structure, where the strata are the firmest and hardest. The inclinations of the edges of the principal joints to each other, are 60° and 120° respectively. Other lines divide the mass, but they are subordinate to these. The dip of the rock is southwest: the angle is, however, very moderate or gentle; and, unless locally disturbed, it never exceeds five degrees.

In order to examine the utica slate in this county, the route which may be pursued is to take the road from Adams to Tylerville. On this road, one mile from Adams, the slate appears in the south bank of the creek, and the trenton limestone on the opposite side. This is a point of some interest, for there is a slight disturbance of the rocks, and the trenton is apparently raised to a level with the slate. The dip of the limestone is west, and its inclination is four degrees in that direction. The fractured edge trends northeast, in a low ridge not exceeding twenty or thirty feet. The south side is underlaid by the slate, though much concealed by soil and drift. At different points upon this road, wherever the creek is examined, we usually find the limestone in its bed, and the slate at no great distance in the banks. Natural joints of the limestone on this route, N. 45° E.; at five miles from Adams, they are S. 75° E.; dip southwest. Natural joints of the slate, N. 45° E. The slate is entirely conformable to the limestone on which it rests.

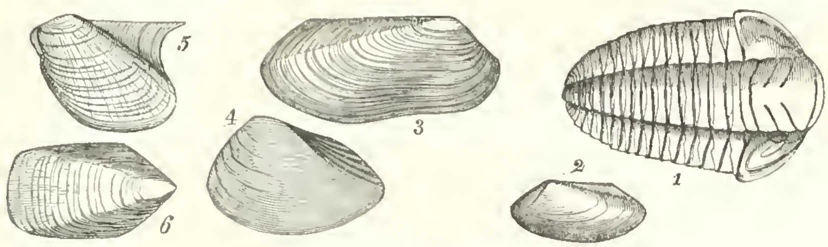
The slate of the gulfs or ravines is frequently in a state of perfect decomposition, lying in mass on the banks, and sometimes in powder like a pile of ashes. This result has been produced by the dissemination of sulphuret of iron. The taste of this decomposed mass is slightly styptic, but indicates only a small proportion of the sulphate of iron. The cliff underlaid by this material is of course constantly falling down, being undermined by the washing out of the slate by rains, and by its own imperfect coherent state. It is not improbable but that this mass of decomposing slate might be converted into alum, by pursuing with it the usual method. An experiment could be tried at a small expense, and the material is so abundant and accessible that it certainly deserves some attention by those who own the soil.

A very large proportion of the slate, wherever it is exposed, exhales a strong bituminous odor on being struck or broken; and frequently, in the fracture of a large mass, the odor may be perceived twenty feet distant.

As a whole, this rock is less firm and indurated in this county than in the Mohawk valley, or upon Lake Champlain. It appears never to have been subjected to so much pressure and to such powerful disturbing forces as elsewhere. It presents simply the fragile argillaceous slate of authors, without siliceous matter, or beds of shale, as in the succeeding mass. The great differences which may be observed, are those resulting from disintegration, which is rapidly going on where it contains pyrites.

This mass contains a great abundance of the fossil common to it elsewhere, the Graptolites dentatus (No. 2, p. 279); and it also contains the Trocholites ammonius (No. 3), which, however, is rare, so far as my observation extends. A smaller and smoother trocholite is more abundant. The species most abundant in this region, are exhibited in the following cut:

110.



1. Triarthus beckii.
2. Nuculites scitula.
3. Cypricardites sinuata.
4. Nuculites poststriata.
5. Avicula.
6. Lingula rectilateralis.

No. 1. The *Triarthus beckii* is probably the most constant and characteristic fossil of the rock. I have not observed it in the slaty limestone of the trenton, nor in the shales of Loraine. It is abundant in the gorges at Rodman and Loraine, and upon the route from Adams to Tylerville, wherever the slate is exposed. The head is the part usually found, which, from its peculiar markings, is readily distinguished from the head of the Calymene.

No. 2. *Nuculites scitula*, is extremely common immediately below the loraine shales, or in the upper part of the utica slate; and as this part is often absent, the peculiar fossils are seldom met with.

No. 4. *Nuculites poststriata*, is not a common fossil in Jefferson, or at least has not been observed very frequently.

No. 5. *Avicula insueta*, belongs to the Mohawk valley. I did not find it in the slate of the Second district.

No. 6. *Lingula rectilateralis*, is associated with the Triarthus.

The inferior part of the slate abounds less in organic bodies than the superior; in fact, in some districts, as upon Lake Champlain, thick heavy beds appear to be destitute of all of them, except the Fucoides dentatus. Next in frequency of occurrence, is the Triarthus beckii. The remainder of those which I have figured, appear to be confined to the upper part of the rock.

In assigning the limits to this rock, I have been governed wholly by the presence of the Triarthus; and as this occurs associated with all the fossils of which I have given figures, I

deemed it right to place them in this rock rather than in the loraine shales which succeed. The mineralogical characters of the slate continue up to this line ; but immediately above, the shaly layers commence, which are very barren of fossils. Above the plane upon which these fossils rest, a change soon appears ; but up to this plane, the mass is homogeneous, and characterized by the fossils which I have introduced. The remark made by one of my colleagues, that the upper part of the utica slate is destitute of fossils, I think is based upon the fact, that the mass which contains those described above, and which I consider as belonging to that part of the rock, is washed away from the valley of the Mohawk, or does not appear there. But in my district I find these peculiar fossils in a position by which they are protected in the gorges of Rodman and Loraine. And besides this, I know that in many places the rock is uncommonly barren of fossils ; and to me there is in reality no discrepancy in our observations, when we compare the two fields or districts together, and the varying character of the masses.

In this State, and particularly in Jefferson, I have been unable to find a commingling of the fossils of the trenton limestone ; for instance, those which follow, are strictly limited to the limestone and its shaly part, viz. Orthis testudinaria, Strophomena alternata, Lingula ovata, Favosites lycopodites, Isotelus gigas, Calymene senaria, and Graptolites dentatus. Of these, the last only have I discovered in the utica slate ; and I would suggest, that when the preceding fossils have been supposed to occur in this rock, whether, in reality, they were not found in the slaty part of the trenton limestone ? For if any fossils are characteristic of the trenton limestone, these certainly are the ones.

The surface of the country underlaid by the utica slate is hilly, but rounded. It is also more or less intersected by steep ravines, which follow the course of the creeks ; a result which arises from the disposition of the rock to disintegrate, wherever it is exposed to water. Where this rock prevails, the soil, being both rich and deep, is highly favorable to agriculture, producing abundant crops of grass and grain, and affording good pasturage.

To determine the whole thickness of this rock in Jefferson county, I made several careful examinations of it in the deep gorges of Loraine. I was the more desirous of making an accurate estimate here, as the rock is elsewhere so much deranged and confounded with slaty masses of the loraine shales, that it is difficult to obtain satisfactory results. From the estimate, as well as measurements at some points of exposure, I am satisfied that its thickness never exceeds seventy-five feet. This is less, I know, than the estimates of other geologists ; and it is highly probable that, in other districts, the rock is thicker. It is not improbable, too, that the mass in this direction is really thinning out, being situated near the edge of the great basin in which the rocks composing the Champlain group were deposited, and hence its thickness will increase towards the Mohawk valley. But I have sometimes been suspicious that the thickness of rocks has been over-estimated, partly from their deranged condition, when it is impossible to determine the limits of a mass where it is deranged or concealed partially beneath the surface.

Loraine Shales.

In the general description of the rocks of the Second district, I proposed to change the name of this rock, substituting *Loraine* for *Pulaski shales*; and though the latter had been used in the annual reports, and there are objections to a change of name when it can be avoided, or when no sufficient reason exists, still in this case it appeared to me that a change was required; for if the principle for local names is good, it is evident that the locality from which the name is to be derived should be one where the most important characters of the rock are best displayed. It was upon this ground that I proposed to substitute *Loraine* for *Pulaski*; the whole mass, with all the relations of the inferior and superior rocks, being exposed either in the gulfs of Loraine, or in the adjacent country. If, therefore, a complete and satisfactory knowledge is wished of this rock, it is necessary to visit Loraine. At Pulaski, the upper part of the rock only is exposed; but the deeper beds, those which give to the mass its mineral characters, are not exposed at this place. There seemed, therefore, sufficient reasons for the change proposed.

In this mass, we find a great diversity of materials. In this county they are composed of,

1. Thin even-bedded sandstone; grey internally, but becoming brownish or brown by weathering.
2. A shaly sandstone, weathering as in the preceding.
3. Fine grained, fragile slate, mostly argillaceous, and invariably exfoliating on being moistened or wet after having been dried.
4. Strata composed of calcareons matter and shale, varying from one to ten inches thick. They are mostly a mass of fossils, and become brown by weathering.
5. A stratum of compact, fine-grained limestone, intermixed with carbonate or oxide of iron. This is from six to ten inches thick; and though it appears an unimportant part, yet it extends over a wide surface, and occupies a definite position. It resembles the ironstone of the coal measures, and sometimes furnishes a mass in that curious form called *cone in cone*.

The whole mass is characterized by alternating beds of shale and slate, with a great preponderance of the former. From the utica slate, for two or three hundred feet, thin grey shaly sandstone predominates. In this part, a few fossils were found: one orthoceratite, a strophomena and pterinea. The strata consist usually of thin laminæ bent or curved among themselves, partly in consequence of each individual layer thickening and thinning out, giving the strata a waved appearance when worn. When used as a flagging stone, these layers present this peculiar appearance.

The change in mineral character from the utica slate is gradual, the slaty or argillaceous strata are replaced slowly by those which are siliceous; and though the steps of this change may not in all cases be equal, yet we find in the end that the argillaceous matter disappears; as when the grey sandstone is formed, this substance is only found in small insulated masses, but rarely in sufficient amount to form a continuous stratum.

The boundaries of the loraine shales are well defined on their northern outcrop.

From near Mannsville, the line of outcrop runs northeast, passing two and a half miles east of Adams to Whitesville and Tylerville, whence, in two or three miles, it takes an easterly direction, and passes from Jefferson to Lewis county.

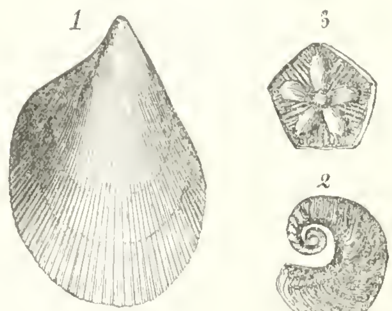
According to this line of outcrop of the rock, the east part of Ellisburgh, all of Loraine, a corner of Adams, one-half of Rodman, and the southeast corner of Rutland, are underlaid by the loraine shales. In the south part of Loraine, however, the grey sandstone has become a mass of some importance, but its real extent I have been unable to determine.

The preceding facts and remarks will put the reader in possession of the geographical distribution of the rocks of this county, and furnish him with their lithological characters. It will be observed, that proceeding from north to south, the rocks rise both geologically and geographically; that in the southern townships, we find the highest land and the highest rocks; that we go up step by step from the potsdam sandstone to the loraine shales, or rather the grey sandstone.

What remains to be stated of this rock, relates to the organic bodies which it embraces, and the orders and forms of living beings which existed during its era of deposition. One remark may with propriety find a place here, namely, that though some of the fossils, particularly the genus Strophomena, bear a strong resemblance to those of the trenton limestone, still I am of the opinion that they will be found to belong to different species. Whether this will prove true or not, the characters of the fossils in general are so distinct, that no difficulty can arise in recognizing the rock from its organic remains.

The first group of fossils which I shall introduce to the notice of the reader, are probably specific.

111.



1. Pterinea carinata. 2. Cyrtolites ornatus. 3. Pentacrinites hamptoni.

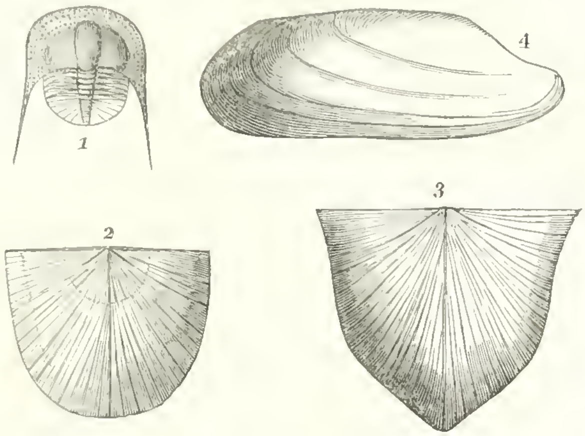
No. 1. *Pterinea carinata*, is always abundant, and has the greatest range in the mass. At Loraine, I found this fossil from the top to the bottom of the series, or within four feet of the Triarthus beckii. It is, however, rare in the lower layers; but its discovery proves that this mass is single, or that it is strictly *one rock*, and ought not to be subdivided; besides, we have the support of other fossils which extend deeply into the mass. In no instance, however, did I succeed in obtaining the fossils of this rock in the utica slate.

No. 2. The *Cyrtolites ornatus*, is confined mostly to that stratum which contains carbonate of lime. It is usually weathered and brown.

No. 3. The *Pentacrinites hamptoni*, is also quite extended. It abounds in the upper layers, and appeared very early in the mass. In the middle portion, few other fossils are found, and

it covers very frequently large surfaces. The parts are usually detached from each other, in consequence of the destruction of the ligament which binds the columns together. We find merely a single ring imbedded by itself in the shale ; and though they are extremely abundant at Loraine, yet the heads of the animal are exceedingly rare. Its specific name is derived from *Hampton*, where it was first discovered. It is equally abundant at Pulaski and Saratoga, and indeed wherever this mass has been examined in New-York. The head and the parts surrounding it are very diminutive and delicate, in comparison with the size of the vertebral column.

112.



1. Trinucleus caractaci.
2. Strophomena.
3. Strophomena nasuta.
4. Cypricardites modiolaris.

No. 1. The first fossil of this group was found towards the upper part of the loraine shales, in a very fine bluish slate. The bed was exposed in repairing a mill-dam near the centre of Loraine ; and judging from the fragments thrown out, thousands must have occupied this location. They are very perfect at this locality, the animal being entire in all its parts. I have preferred to consider this as the same fossil figured by Murchison in the Silurian System, and belonging to the Caradoc sandstone, though some slight differences appear to exist. The spines of the buckler in the Loraine fossil, are twice the length of the body and tail ; but in the figures of Murchison, they are considerably shorter, which circumstance I suppose may have arisen from the imperfection of the specimens.

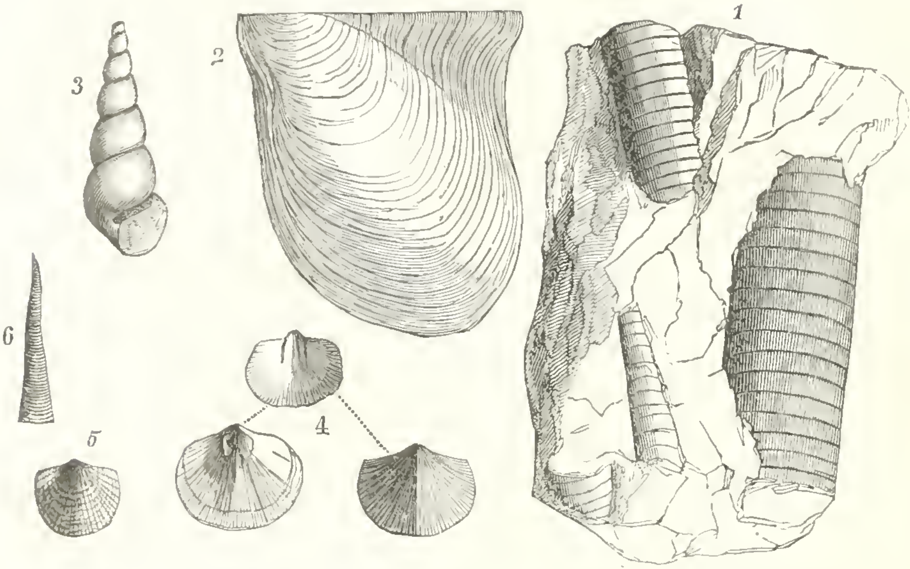
The Trinucleus of Loraine is clearly distinguished from the one in the trenton limestone, by the width of the perforated margin of the buckler, the number of perfect circles of perforation, and the length of the spines. Some of the individuals are one-third larger than the drawing, which is the average size of the petrifaction.

No. 2. This Strophomena is common upon the same surface with the following, but it is too much rounded to be the flat valve of that species. One which strongly resembles it, is found deep in the mass of shales.

No. 3. The *S. nasuta*, is abundant in the lower part of the grey sandstone, to be described in the next section.

No. 4. The *Cypricardites modiolaris*, is one of the fossils which, along with the Pterinea carinata, appear strictly confined to this rock. Neither of them have left any vestiges in the trenton or utica slate.

113.



No. 1. Orthoceratites æqualis. 2. Avicula demissa. 3. Pleurotomaria. 4. Orthis testudinaria? 5. Orthis crispata. 6. Tentaculites.

No. 1. The *Orthoceratites æqualis* is quite abundant in the shaly or more sandy part of this rock. A much larger one resembles this, and appears common in the same stratum; and another also resembling it, is found one hundred feet below, but it is quite rare.

No. 2. *Avicula demissa* is found in the lower part of the grey sandstone: this is also rare.

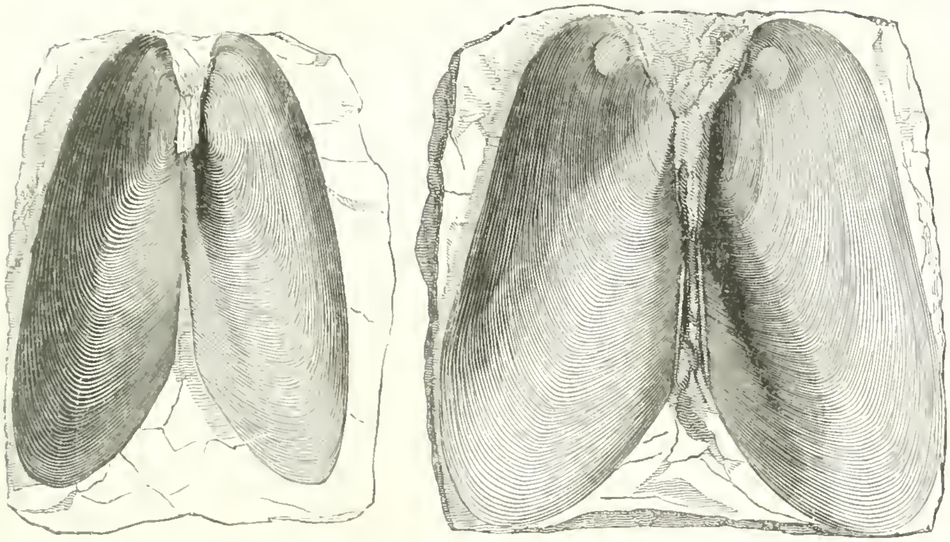
No. 3. *Pleurotomaria* ——, occurs in the soft argillaceous mass near the top of the rock.

No. 4. *Orthis testudinaria*? It is impossible to decide with certainty whether this is the true testudinaria, or the one so called in the trenton limestone. Each figure is a drawing of the different casts, which will be recognized by inspection.

No. 5. *Orthis crispata*, is associated with the preceding, but is not so abundant at Loraine.

The *Tentaculites* ——, is very common in this rock; at Loraine, it is more abundant near the upper part of the rock.

114.



1. Cypricardites angustifrons. 2. Cypricardites ovata.

The preceding figures are offered as an illustration of the palæontology of the Champlain group. I have been able to furnish the most important of all the sedimentary rocks of the Second district, the principal motive having been to give accurate drawings, by means of which comparisons could be made with the fossils of other rocks in other portions of the State and country. I have not deemed it so necessary, in this place, to settle and clear up all doubts as it regarded identity of species, as to obtain good figures for comparison. I have therefore omitted the specific names in several instances, considering these as of little consequence in comparison with the determination of the position and range of the fossils themselves.

In this connection, I may remark farther, that it will be seen from the preceding figures, that all the sedimentary rocks of the Second district are fossiliferous, and that the lines of demarkation between the rocks are very strongly defined by the fossils alone. To the practised eye, very little difficulty is experienced in distinguishing the rocks by means of their lithological characters; but it is only by means of the fossils, represented truly in drawings, that correct comparisons can be made abroad. These enable the geologist to institute at once those comparisons which are necessary to establish identities or differences between rocks at a distance. Though a minute detail be given of the lithological characters of a group, still it is impossible to present it as it is; but when an accurate figure is given of an imbedded organic body, there is furnished at once as it were a living character, one that is far more constant than even the mineral character of the group or rock itself.

Grey Sandstone.

Towards the south part of Loraine, the shaly matter of the preceding rock has diminished so much that the mass has become a sandstone. The siliceous matter, however, is somewhat changed, and it is of a lighter color than the sandy layers of the loraine shales. When the sandstone is fully formed, it often contains thin layers of shale, but the siliceous layers predominate greatly over the slaty. Sometimes a fine green slate is insulated or inclosed in the sandstone. As a whole, the mass is a uniform greenish grey rock, composed of grains of quartz but little larger than a white mustard seed, and indeed the size is often too small to be observed. It appears similar to the ordinary stone used for grindstones — a pure sandy sharp-gritted rock.

As the loraine shales pass into this grey rock, the fossils diminish both in number and kind; so that when the sandstone is fully formed, very few fossils remain. The Avicula demissa and Strophomena nasuta were obtained in the quarries of this sandstone near Rome, but they appear to be confined to the lower part of the rock.

This mass appears, from its position, to be equivalent to the greywacke in the Hudson river series. It differs considerably from it, being finer and more even grained; and so far as observation proves, it contains no beds of breccia or rubblestone.

This rock is a valuable material for building; and from its uniformity and evenness of grain, and its freedom from hard uneven layers, it is not only adapted to a variety of purposes, but is quarried at a small expense.

The loraine shales, and the grey sandstone overlying them, are entirely destitute of mineral veins or beds, and even the ordinary earthy minerals rarely form a part of these masses. This fact appears of some importance, when we compare the state and condition of these masses with the same in the valley of the Hudson river. Here they are intersected remarkably with veins of mineral matter; and in this district it is that they are so remarkably disturbed, not, however, by these mineral veins, for they are rather the consequence than the cause of disturbance. The movements to which the masses have been subjected, fissured and rent the strata; and into these fissures and rents, mineral matter has been transported, forming thereby what we term *veins*.

The rocks of the south part of Jefferson have been subjected to but slight and inconsiderable movements; hence we find even a single stratum continuous over almost the whole district, the mass as a whole dipping only gently to the southwest. In consequence, too, of this horizontal position of the strata, we are able to ascertain their thickness; whereas in the Hudson river counties, the same rocks being deranged, it is difficult to ascertain this fact with exactitude.

In the Hudson river valley, there are occasionally imperfect ranges composed of a hard siliceous rock, differing somewhat from the preceding as it commonly appears in Jefferson and the adjacent counties. This siliceous mass occurs in a position analogous to the siliceous rock at the north: it is underlaid by shales; but in them there is a larger proportion of argilla-

ceous matter, generally in the form of shining argillite. The mass lies on both sides of the river, and forms rocky ridges parallel with it; at least this is the fact near Albany. From this ridge there is a descent on both sides, terminating in a depression which runs parallel with the river and ridges. Advancing still, we reach another ridge composed of a hard siliceous rock. Now it being proved or admitted that this mass is equivalent to the grey sandstone described above, it would follow that the thickness of the Hudson river shales proper does not much exceed that of the shales of Loraine. This would therefore take away some of the unexplained points in relation to the Hudson river rocks, and relieve us from the embarrassment of maintaining or assuming that they are twenty or twenty-five miles thick; for it is rather an assumption, after all, made in consequence of not seeing certain lines of demarcation, where the same mass is repeated over and over again.

This subject has been remarked upon repeatedly, but it seemed necessary to recall the attention of geologists once more, that this point may be determined. It possesses more than ordinary interest; for I suspect that some shales present the same facts and anomalies in England and Wales, as in this country.

Extension of the New-York System in Canada.

Having stated the leading facts of the geology of the adjacent territory while describing the formation of Lake Champlain. I propose now also to give a brief sketch of the rocks of Canada, those particulaaly near the St. Lawrence river.

The first remark which I have to make, is, that the rocks of Canada are precisely what we should expect, a continuation of those upon the New-York side. The primary rocks of the Thousand islands are confined mostly to those islands; that is, they do not extend much beyond the opposite shore. At Brockville, gneiss forms a low ridge in the south part of the village; but to the west and southwest, it is concealed by other rocks. At this place, the sedimentary rock is the potsdam sandstone, or the lower part of the calciferous. Three miles west, we rise one step in the series, and find the upper part of the calciferous well developed. This rock continues twenty-two miles in a southwest direction, or to the head of Plumb valley. It is then succeeded by the potsdam sandstone: this forms a belt of a few miles in width, and then the primary succeeds.

Without intending to go into particulars or details in an extra-limital survey, I shall state generally, that in this direction, the rocks of Canada are similar to those of St. Lawrence: first, the sandstone is merely an extension of the potsdam rock; then the calciferous is also much the same; and when we reach the primary in Beverly, Lyndhurst, or in the region of the Gannanoqui, it is a repetition of the primary limestones, albitic granite, and the various compounds formed by intermixture of the two, and similar in all respects to the rocks of Gouverneur, Rossie, Fowler and Edwards. The similarity extends farther; the rocks present the same phenomena in regard to veins and imbedded minerals, so that all the circumstances relating to the geology of the two regions are identical. But there are some points of

difference, though I am not able to state how extensive these differences are, and whether they extend to the masses generally, or are merely local. The differences which I refer to, consist in the dip of the rocks when stratified, and of the veins traversing them. Thus in Canada the gneiss dips east, while in St. Lawrence and Jefferson county it is west or northwest, leaving out of view local exceptions. The lead mine near Furnace falls dips south, while the Rossie vein dips north. Such are a few particulars in which the geological phenomena differ; but as it regards composition, or the materials which enter into the formation of the rocks, there are no essential differences. The trap dykes pursue courses varying but little from an east and west course; such is the fact in relation to the lead vein just referred to.

The breadth of the sedimentary rocks on each side of the St. Lawrence is nearly equal; so that this river flows in a channel which seems to have been formed in the central part of the beds; not as usual near the edge of a formation, where the rocks are thinnest; for there can be no doubt that the route of this river was first determined by a fracture and slight uplift. A light dip exists to the east on the east side, and upon the opposite side to the west. The greatest depression is along the river, and at the termination of the calciferous and potsdam sandstone.

Other phenomena, which are strictly geological, correspond with those upon the east side of the St. Lawrence. Thus the lakes are narrow, having their longer axis in a northeast and southwest direction; and like the rivers, their beds or channels appear to have been formed partly by fractures in the rock, which were afterwards deepened by water moving with more than ordinary force. We find, too, that they all belong as it were to one system; that is, they are parallel to each other.

The breadth of the calciferous and potsdam sandstone on the St. Lawrence river is full sixty miles, on a line passing east and west through Ogdensburgh and Prescott. On the Canada side, the sedimentary rocks spread out much wider towards Bytown on the Ottawa. The same fact may be stated in regard to their extension toward Hopkinton on the New-York side, but here the form of the country is different.

The preceding facts in relation to the geology of Canada are, I am sensible, exceedingly meagre and barren of interest; still they serve to supply a few items of geology, and give some additional knowledge of the extension of the New-York rocks in an adjacent province.

Gulfs of Loraine and Rodman.

The term *gulf* is applied to several long, deep and narrow excavations in the rocks of Loraine and Rodman. They are bounded by perpendicular walls of rock from top to bottom, with but few places where the slopes are sufficiently safe for descent, or upon which it is possible to ascend. Through these long narrow deep passages the creeks of this region flow; in fact, they are but the channels which the creeks have worn for themselves in a shaly thin-bedded rock, a large proportion of the layers of which are perishable from their composition and structure. They terminate towards the west or southwest, just beyond the limits of the

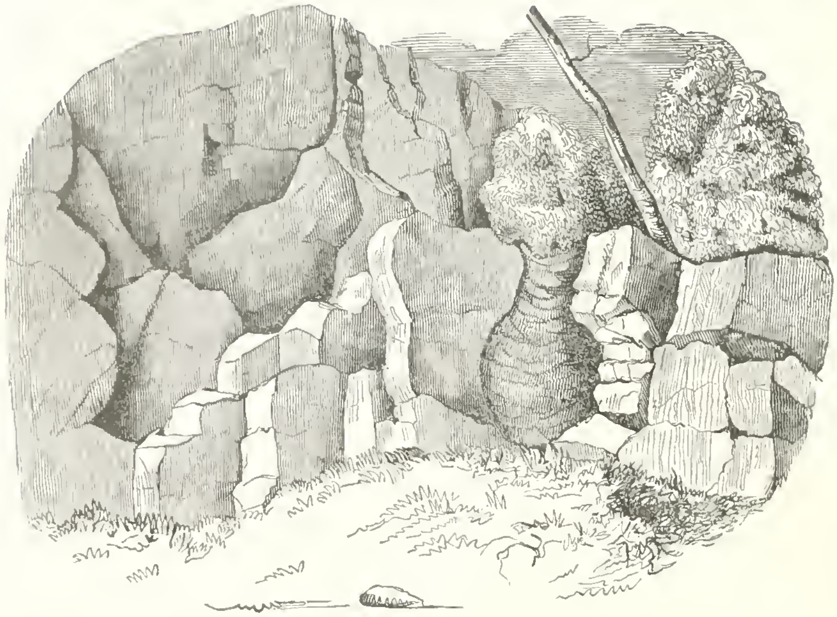
shales. They open gradually, or become gradually enclosed by walls continually increasing in height as they are penetrated towards their head or origin. For example, the gulf in Rodman terminates near Sodom. Passing up the gulf, we find the foundation rock is the trenton limestone, and it is worn to the depth of twelve feet by the gulf stream. In ten rods, the black or utica slate makes its appearance, resting on the limestone: it is about ten feet thick at its commencement. Ascending seventy or eighty rods farther, the slate has become thirty feet thick, and the limestone which is exposed, much less. In a mile or a mile and a half, the walls upon each side have attained a height of two hundred feet; the trenton rock has disappeared, and the utica slate forms the floor of the gulf, the sides of which are composed of the loraine shales. The greatest height of the walls which I had an opportunity to measure, is three hundred feet. In tracing them upward after the gulf is fully entered, they vary in height from one hundred to three hundred feet. This height is slowly but gradually increasing by the continually wearing of the utica slate in the bottom of the gulf, which, when entirely cut through, will increase the height of the walls to three hundred and seventy-five feet. The width or distance from side to side is about sixteen rods, but it depends much upon the windings of the stream.

The gulfs in all cases commence with the origin of the streams, beginning to be worn immediately from the very point where the springs issue from the ground. The length, therefore of the gulfs, comprises mostly the entire length of the sandy creeks. According to some estimates, and from inquiry made upon the spot, their length, including some of the windings, exceeds twelve miles. These long passages in the rocks afford the finest opportunities for exploring the deeper seated beds. The trenton, being the first rock, is partially exposed; the utica slate is entirely cut through, and so is the mass composing the shales.

These gulfs, besides being objects of geological interest, are well worthy of a visit from the traveller who seeks recreation and amusement; for few objects in our country possess a greater share of the marvellous than these. Hitherto they have received no attention, which is rather remarkable, as they are quite accessible, being near one of the common travelled routes from Rome to Watertown.

The number of gulfs I am unable to state. I found that every stream of much size flowed through one. The longest and most important are upon the main branches of the South-Sandy creek.

115.



Perforation of granite near Oxbow, from a drawing by E. Emmons, Jr.

Distribution of Drift and Boulders, &c.

The facts in relation to the distribution of drift and boulders have been in part anticipated. The same causes which have grooved the surface in many places so deeply, have also been instrumental in the dispersion of the boulders and loose materials over the surface.

In this county, as in others, boulders are found in particular sections or districts. They are not, as might be inferred from the remarks sometimes loosely made, spread over the whole surface without regard to its level; they are, on the contrary, arranged in zones, the greatest number being found in the higher parts of certain districts. It is true, that they are found almost every where; but by these remarks, it is to be understood that they are far more numerous in some districts than others, and that this is a result which is uniform, and may be connected in each instance with one cause.

In Jefferson, the zone of boulders, or the boulder region, is about two hundred or two hundred and fifty feet above the level of Lake Ontario. I may err in this statement, as it regards the approximate height; but it is not far from the truth. Boulders are scattered over the southern parts of the county. Upon the lake shore, granite, gneiss, hypersthene and hornblende compose the principal ones. The same kinds, also, are found between Henderson and Adams, and in the vicinity of Champion and Carthage.

But the region in which the boulders are greatly multiplied, is that upon the slope of the range of hills south of Watertown, and extending in an irregular band or zone of the same

elevation south, ranging about two or two and a half miles southeast of Adams towards Loraine, and thence towards Mannsville. Some portion of this band of boulders lies along the common travelled road leading from Adams to Mannsville.

The region which I have imperfectly defined, may strictly be called the *Boulder region*; and all parts of the State where the surface and elevation resemble this, and analogous conditions exist, will furnish a region in which the same disposition will be found in regard to the arrangement of the boulders. It has been interesting, in noticing the kinds of boulders, to find among them the hypersthene rock, which, as the reader will have observed from remarks in other parts of the volume, is found in place principally in the western part of Essex. But those which occur upon the St. Lawrence and Lake Ontario cannot be traced to the Essex mass, but must be referred to the more northern regions of Canada or Labrador.

Besides the distribution of drift and boulders, our attention is directed to another class of effects, the cause of which is perfectly well understood, but which is as surprising as to find the rocks of Labrador encircling our mountains and hills. I refer to the wearing out of deep holes in the rocks of some of the ridges of Jefferson, usually called *pot-holes*, from their shape resembling a pot. The peculiar form which these holes always take when made by running water, is such that there is no possibility of error in assigning one and the same cause for their production wherever they may be found, whether in the present reach of running water or not. No cause whatever is capable of producing a deep hole in a solid rock, except a current of water moving with a sufficient power to carry around a quantity of stones.

One of the most remarkable of these holes is in Antwerp, about three-fourths of a mile south of Oxbow. It is in a high cliff of granitic rocks, rising up on the west side of the road. This cliff is the western border of a valley one hundred rods wide. The perpendicular face of the rocks in which the pot-hole is made, is thirty or thirty-five feet. Its appearance from the road is represented in the sketch at the head of this article.

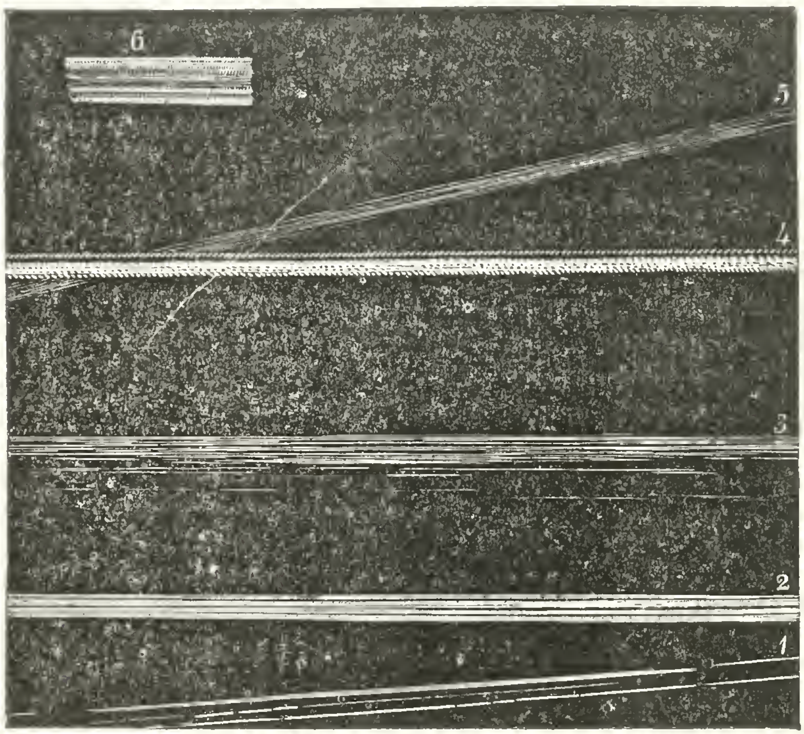
The hole is from twenty-four to thirty feet deep, and from twelve to fourteen feet in diameter; about twelve feet in the neck of the passage, and fourteen in the largest part. A large mass of stones remains in the bottom, which were left by the water when it ceased to flow in this valley. The ledge of rock is about one hundred feet, and perhaps more, above the Oswegatchie.

The effect observed in this instance, is one which I have already remarked may be traced to its cause. No doubt can exist in the mind of any person, who has once seen a pot-hole in a creek or river, but that this appertains to the same class of phenomena. It is impossible, however, to say when it was produced, or in what direction the river flowed, for there has been a change of the surface of the country. But there is one point which may be determined: it is in relation to the movement of the subjacent rocks, which without doubt have been elevated, and, in consequence of this elevation, have turned the channel of the waters in some other direction.

Other pot-holes, I have been informed by Mr. Bailey of Hammond, exist three miles below this place, about fifty feet above the St. Lawrence river. These I have not seen; but from the accuracy of Mr. Bailey as an observer, there is no doubt of the fact as stated.

We have, both here and elsewhere, three phenomena related in kind to each other; but whether they are related as to cause, cannot at this stage of our inquiries be determined. I refer to the scorings or scratches upon rocks, the distribution of boulders, and the wearing of rocks in the mode represented by the cut at the head of this section. As some of my readers may be unacquainted with the appearance of a rock which is scratched or scored, I have introduced a cut which exhibits, as well as possible, these peculiar markings. I have borrowed it from my colleague Mr. VANUXEM, who procured it for the purpose of showing the tremulous motion of boulders when passing over the surface, which is indicated by the regular interrupted lines.

116.



In all the effects specified above, water is concerned, but in each case the circumstances are modified. In the first, water bears along rocks and stones, gravel and sand, frozen into cakes of ice; in the second, boulders are frozen probably in large masses of ice, termed *ice-floes* or *icebergs*, which, floating out to sea, melt gradually away, and drop them as it may happen, or as they are thawed out. Now these icebergs float in directions quite constant, and hence may ground regularly upon the sounding of certain shores, where the greater part of their burden of rocks is dropped. By this hypothesis, I would explain the collection of boulders in certain zones or belts. The third or last phenomenon has nothing to do with ice:

it is produced by water moving in small circular currents with great force, and thereby giving a rotatory motion to the stones which happen to come within the eddying current. If these remarks are founded in fact, the three phenomena may be connected with moving water as their common cause; but in the three different cases the circumstances are different, and in each case the effects are specific.

Of the debris of rocks in situ, and of the sandy regions of this county.

The soil in the vicinity of Adams, and towards Loraine, is made up of particles or laminæ which have been derived from the utica slate. The slate appears to extend deep, and is not simply a superficial covering, but enters into the composition of the soil to the depth of ten or fifteen feet. The same fact may be stated for the whole range of this rock, in the direction of its outcropping edge.

There are two regions in which sand forms a thick covering over all other materials. The first is in Ellisburgh, upon and adjacent to the lake shore. Immense beds have accumulated at the mouth of Sandy creek. Another more important district, however, of this material, occupies the central part of the county. It lies upon the Black river, and in its vicinity. It extends from Leraysville to the Wilna road leading from Carthage to Antwerp, which is about ten miles. North and south, it extends eight or ten miles, or from the Great bend to Sterlingville. This region is a level plain, a large proportion of which is covered with forest, mostly pine. It forms, along the river, high sandy banks upon the north side. Within the curvature of the river, the land is low and level, and is composed of clay.

In the two last regions, the surface soil is evidently transported matter. The sand in the region of the Sandy creek was derived from the great gorges of Loraine and Rodman, and resulted from the disintegration of the great mass of shales, which have been entirely removed from their thin beds. The sand of the Great bend is probably drift, which was transported from the north.

The soil composed so largely of slate, has resulted from the destruction of the utica slate: it is in place. It is first formed by the exfoliation of the laminæ while the masses are in their beds; and it is subsequently farther changed by a continuation of the process, until it is finally reduced to its original condition, that of clay.

Recapitulation of some of the leading Facts in the Geology of Jefferson County.

1. The primary rocks are similar to those of St. Lawrence, and occupy the northern and eastern part of the county. They are arranged in low ridges, which have a general parallelism.

2. The succession of the sedimentary rocks is from north to south, proceeding from the potsdam sandstone to the loraine shales in a series of terraces.

3. The surface is marked by valleys traversing the county from northeast to southwest, a direction which corresponds to the natural joints of the rocks.

4. The extent of the rocks has been diminished by the action of water in different states and circumstances; the general effect has been to break up, and afterwards disperse the fragments of the rocks.

5. The boulder region is near the base of the highest hills in the county, and extends south from Watertown towards Mannsville.

6. The surface at some period (probably recent) has been elevated, so as to produce a change in the direction of the rivers.

7. The minerals, which are confined principally to the north and northeast part of the county, are the same as those of St. Lawrence.

8. The county is adapted to agriculture; the soil, exposure and temperature fit it for grain, grass and pasturage. The quantity of soil derived from the underlying rocks is much greater than in St. Lawrence, as both the limestones and shales have assisted in forming the soil of Jefferson county.

HAMILTON COUNTY.

Hamilton county is situated in the central part of that division of New-York which is north of the Mohawk valley. As one of the civil divisions of the State, it is cut off from any of the great natural channels of communication with commercial cities; it touches nowhere upon any outlet, by which its productions can find a market. It has therefore the fewest natural advantages, and is the most insulated county of any in Northern New-York.

Mountains; Surface; Lakes.

This county is traversed by two ranges of mountains which pass nearly centrally through its territory, and by a third which passes through the southeast corner, touching upon the township of Hope, and extending northeast through Day, Athol and onwards, and finally terminating at or near Crown-Point on Lake Champlain. The second range lies between Hope and Lake-Pleasant: it is the range which is crossed in going from the former to the latter place. It varies from six to ten miles in width; its elevation, in this county, probably never exceeds four thousand feet; but in its northern extension through Essex, it forms the highest mountains in the State. It forms the Clinton range, which has been described in the preceding pages of this report, and the central and highest part of which composes the Adirondacks. In this county, the highest land is in township No. 19, and the whole of this range traverses the county southeast of its central part.

Another range, running parallel with the preceding, traverses the county nearly centrally. It has less regularity in the arrangement of its ridges, and is more divided into insulated mountains than the preceding. It is distant from the preceding range about six miles; it runs through the northwest corner of Newcomb in Essex, and the southeast corner of Franklin; and as it passes onward in this direction, it forms the range of mountains between Clinton and Franklin counties, and finally terminates in the hills of Ellenburgh and Chateaugay. It is possible, however, that it may really terminate farther east in the range of hills in the west part of Champlain and Mooers. The country not being traversed by distinct ranges, but by broken mountains and hills, farther observation and comparison will be necessary in order to determine the termination of their range satisfactorily.

The surface of Hamilton county is therefore broken into mountains and hills. The slopes, however, are rarely steep, especially those of the lower class; and hence they form good fields for pasturage.

The lakes of Hamilton form perhaps the most distinctive feature of its surface. Situated as it regards height, at that elevation from which there is a drainage towards all points of the compass, its surface necessarily becomes the platform upon which the large lakes are spread, which give origin to many of the noble streams that water the State both towards the north and south. In fact, it contains a great number of the large reservoirs of waters, which supply the Hudson, Black, Racket, and other northern rivers with their inexhaustible currents; and those deep pure fountains which, while they are spread out to adorn and beautify its own surface, varied with hill and dale, forest and meadow, mountain and plain, are still the never-failing sources of the noble rivers which water the south and the north, conveying in their channels, not the pestilent miasma of dead marshes, but pure water, the emblem of life.

The lakes of Hamilton may be separated into two regions: the southern, including Lake Pleasant, Round and Piseco lakes, with many others upon the same level, together making up the amount of water which forms the Sacandaga branch of the Hudson; and the northern, in which are included Racket lake and the Fulton chain of lakes, together with Long lake, which form the waters of the Racket and other northwestern rivers. The Racket and Long lakes are the largest and most important of any upon the northern table land. The former, though only fourteen miles in its greatest length, still, from the extent of several bays, and its greatly indented shore, forms upon the whole a large extent of surface, covering the whole area of township No. 40. Long lake is eighteen miles long, but varies in width from half a mile to three; it is shallow in some places, but is any where of sufficient depth to float a vessel of one hundred tons burthen. These lakes, together with their bays, inlets and outlets, and other waters which may be connected with them, are capable of forming an extended line of water communication, by which a large portion of this section of country may be traversed; and probably the time may not be far distant, when it will be thought expedient to form and perfect some of the natural channels of communication which intersect this part of the State.

In a direction northeast from Racket lake, is a chain of smaller but beautiful lakes, which together form the upper waters of the platform. This chain was called, in the Report of 1841, the *Eckford chain*, from its principal lake, which is about five miles long. The upper lake of this chain is called *Lake Janet*, from a respect entertained for the accomplished lady of the Zoologist of the Survey. The several lakes of this chain unite their waters, and form a deep serpentine river, which empties itself into a long and deep bay on the east shore of Racket lake. This river, in the report just referred to, was named *Marion river*.

During the preceding topographical details, I have not forgotten that my business is with geology. But while this is true, I would remember that in a community constituted like ours, many individuals require recreation during certain seasons; and while I am occupying time and space in details of this kind, I am also making known a new field for relaxation from business — one which has peculiar advantages and many resources for restoring health and spirits, such as are unknown at the more fashionable watering places. In this course, therefore, I feel that I am not travelling out of the sphere of usefulness. The breezes of Hamilton are invigorating; the lake scenery is magnificent, and the exercise it calls forth is healthful; and the invalid who, after reaching these romantic wilds, makes a rational use of the forests and lakes and the skies which invest them, and returns dissatisfied with what he has received, I should pronounce not only difficult to please, but mistaken in the objects of his search and in the character of his wants.

Again, from the head of Racket lake, a more remarkable chain of lakes extends out into Herkimer county, through which an easy passage is provided to the great north and south travelled road leading from Utica to Watertown and Ogdensburgh. This chain has been named the *Fulton chain*; one half of which belongs to Hamilton, and the other to Herkimer county. It extends from Racket lake to that tract of land which is so generally known as the *John Brown tract*.

Primary and Sedimentary Rocks.

It is probably understood from the facts already communicated in this report, that this county is essentially primary. The predominant rock is gneiss, with transitions into hornblende. In the vicinity of Lake Pleasant the rock is gneiss, with a large amount of hornblende, and containing large imperfect garnets: it extends towards Lewis lake in township No. 8. There is little variety in the character of the masses which together constitute the primary rocks. Primary limestone appears at intervals throughout the entire region, accompanied with its usual associate, serpentine; and although the main rock of the country is stratified, still the limestone preserves the characters which belong to it when associated with an unstratified rock. The gneiss of the central and northern parts of the county differs only slightly from that of the southern. In Racket lake it contains hornblende, and dips northwest. At Brown's tract, the gneiss is of the same character, and dips also northwest. At the Seventh lake, it dips northwest also, and contains tremolite and rose quartz. The general strike or

range is northeast and southwest. The gneiss around Lake Janet contains many large beds of primary limestone, suitable for quicklime.

In the whole of Hamilton county, though the primary masses present some variation in kind and in their characters, yet so unimportant are these diversities, that when it is stated that the rock is gneiss with transitions into hornblende, and occasional associations with primary limestone, most of the important facts in relation thereto are enumerated.

The sedimentary masses are equally unimportant. There is only a narrow range extending partially up the valley of the Sacandaga. The calciferous sandrock and the trenton limestone were the only rocks of this class which fell under my observation. At Hope I found a few acres of trenton rock, loaded with its usual fossils; and to the south a few miles, the calciferous, each in place. They form the extreme point of the Champlain group, which comes up from the Mohawk valley through Northampton and Mayfield.

Peat. The *vlies*, or natural meadows of Hamilton county, contain a great abundance of peat. In those of Racket lake, this substance is found in larger bodies than elsewhere; but in the lower grounds, it is rarely absent. The natural meadows, which are quite common, and produce spontaneously a grass of which cattle are fond, form an important resource in the settlement of the county, previous to the introduction and cultivation of the crops usually depended upon for the support of stock.

CHAPTER XI.

Some of the common substances which may be employed for economical purposes.

Economical materials existing in the form of rocks.

Mantels, Centre tables, etc. Hypersthene rock, forming in many instances a beautiful material in which the elements are homogeneous, or combined with great equality, may without doubt be manufactured into the richest and most durable patterns for mantel pieces and ornamental tables of various kinds. In this rock there are several varieties, which differ in color principally as it regards a light and dark ground, and the distribution thereon of crystals of labradorite. The varieties with a light ground are generally opalescent, or at least this quality appears in them to better advantage than in those with a dark ground, in which the opalescence is observed with difficulty. There can be but little doubt but that this material can be obtained in a form and condition which will meet with a sale. Mr. Henderson, while superintending some improvements in the reduction of iron ore, placed a block of hypersthene so as to be acted upon by a short common saw which was moved by the machinery of a mill, and found that it cut into the block to the depth of two inches during the day. At that rate, a gang of saws would in a short time cut out slabs suitable for tables or mantel pieces of the ordinary size. Should these opinions be found correct, after some farther experiments, one more source of private enterprise will be opened. This rock is confined to Essex county.

Lime, and *Mortar.* I have ascertained that limestone exists in all parts of the district; and I am of the opinion that it may be found, if not in every township, at least within a short distance therefrom. It was made a special object of search wherever I went. Some difficulty, however, was experienced in finding it in the wooded and unsettled districts. It rises in the midst of the hypersthene rock, in the form of beds or veins; and it is common in the granite and gneiss districts, in the same condition. Hence there will be an abundant supply of lime for mortar, and for agricultural and domestic purposes. The primary limestone is rarely suitable for any other purpose than the manufacture of lime, for it is too liable to disintegration to be used as a marble or building material. The Champlain group furnishes several limestones suitable for marble. The rock beneath the trenton occurs at several places, and also the thick layers of the birdseye upon the Great bend of the Black river, and at Chazy.

The grey trenton limestone forms a fine material for building. The new Catholic cathedral at Montreal is built of this variety of the trenton. It resembles granite, and being equally durable, and much more easily wrought, ought to be preferred when it can be procured.

Substances for clarifying syrups, water, etc. Slate for roofing does not occur in the Second district; but a variety suitable for flagging may be obtained south of Essex, on the lake in Essex county. This rock is used in France for clarifying sugar, syrups, etc. It appears that it is the bituminous variety; and that in order to be employed, it should be burnt and then pulverized, when it is ready for use. The bituminous slate, it will be recollected, occurs at numerous places; and as it is useful for the purpose specified, may it not also be used for purifying rain water for cisterns? The decomposing slates of Loraine and Rodman may open a new field of industry to some of the inhabitants in the manufacture of alum.

Hydraulic lime. Limestone for hydraulic purposes is abundant in the calciferous sandrock. Some variety of opinion is expressed in relation to its qualities, which probably arises from the want of care in selecting the strata intended for burning.

Fire-stones. Rocks which will sustain a high heat without melting, cracking or exfoliating, are termed *fire-stones.* Of these rocks we have three: the Potsdam sandstone, the Rensselaerite and Steatite. The first borders the district on three sides almost continuously; but from this extended mass it is necessary to select those strata which are free from feldspar. This kind is used commonly in the northern counties for the hearths of furnaces; and when the composition is right, that is, when composed of siliceous grains and uncrystallized in the mass, it is one of the best of fire-stones. Rensselaerite may be employed as a lining for stoves, and for all the smaller purposes which may require a substitute for steatite. I placed a small slab of it in the midst of ignited anthracite, where it remained several hours without suffering any change except becoming whiter and harder. Steatite is also found in Fowler, but it is not abundant in the northern district.

Sand for glass. The great abundance of the potsdam sandstone removes the necessity of employing sand, although this exists at several places. Wherever it is found, however, it is derived from the potsdam. The material, either in the rock or in a state of sand, is in the greatest abundance.

Sand for sawing, polishing, and *sand-paper.* The same material, as stated above, may be employed for either of those specified purposes. The rock therefore is one of the greatest importance, as we see when we enumerate the specific objects for which it may be employed.

Glazing materials. The tertiary clay of Lake Champlain forms one of the finest materials for glazing common earthen ware. To glaze the articles, it is only necessary to dip them into a solution or mixture of the clay with water, of about the consistence of cream. The color will depend upon the subsequent burning. It is easy to show why this material may be thus used: the alumina is mixed with a quantity of carbonate of lime, which operates as a flux to the aluminous part. Glazing of a finer kind is found in the feldspars of Chester in Warren county, and in Gouverneur in St. Lawrence county, and several towns in the vicinity. The porcelain clay of Johnsburgh probably contains colored strata which may be employed for some purposes in pottery, either in glazing or forming the body of the ware.

Porcelain clays. Those of Johnsburgh and Athol have been described in another place. The clays resulting from the decomposition of labradorite or hypersthene rock, were spoken of under the head of Essex county.

Moulding sand. Much of the sand of the tertiary beds appears adapted for this purpose. If so, it is quite abundant along the shores of Lake Champlain, wherever this mass has been undisturbed by currents transporting drift.

Fluxes. It will be found that the transition limestones, when formed of a pure carbonate, are much more suitable for a flux in reducing the ores of iron, than the primary limestone. Thus the birdseye, which is very easily broken, might well be substituted for every other. Calcareous spar, or *calcite*, as it is now called, is probably the best. A large bed of it exists near Port Henry. Clay of the tertiary may undoubtedly be used in some instances as a flux.

Clay for fire-brick. The only locality of clay for this purpose, which I have examined, is at Adirondack. This, however, does not appear to be sufficiently changed to form a perfect fire-clay, although it is highly refractory; but it possesses one very remarkable property, namely, that of being heated suddenly, and even raised to a high heat, without cracking.

Ochres and Stone paints. Among the specular oxides, abundance of this material exists, and probably of the best quality. A thin vein of limonite in Dekalb furnishes the finest material I have seen, but it is doubtful whether it is in a sufficient quantity to be wrought to advantage.

Material for copperas. The dissemination of sulphuret of iron is often so abundant as to form a decomposing rock, which may usually be known by its brown color, occasioned by the stains of the decomposed sulphuret. Rocks of this description are quite abundant: they are generally gneiss. Sometimes the sulphuret is in large distinct masses. A locality which appears to furnish the materials suitable for copperas, is in Lewis in Essex county. The manufacture is unprofitable at present; and probably a sufficient quantity can, for a long time to come, be furnished from the Vermont works.

Economical materials in the form of simple minerals.

Mica. Mica for stoves, lanterns, etc., may be obtained in Edwards. It is white, or but slightly tinged with yellowish brown.

Non-conductors for Safes. Asbestus occurs in only limited quantities in the northern district. It is in thin seams in the serpentine rocks at Port Henry. It is very fine and soft, but I suspect the fibre is too short for the uses to which it is commonly applied.

Titanium for coloring artificial teeth. Only a small quantity of this substance has been discovered as yet in the northern district. At Chester, it is found in slender prisms in limestone, and farther search may bring to light greater quantities.

Graphite for drawing pencils. This substance is well known at Ticonderoga, where it forms a regular vein in gneiss. At numerous other places it is found in smaller quantities,

and of a quality suitable for the best drawing pencils, but not in sufficient abundance to give it a commercial value. The demand for this article is now so great, that careful search for it is warranted.

Precious stones. The zircon of Rossie is in sufficient perfection for cutting and setting in all ornamental work, as rings, bracelets, broaches, etc. The black quartz, in dodecahedral crystals, is sometimes handsome, and may possibly be found in the iron mines in sufficient perfection to admit of being employed in ornamental work. The finest materials for these purposes, however, is the labradorite, which may be obtained in large pieces. One or two fine specimens of calcedony have been found in the trap dykes, which were truly gems.

The preceding list of substances is inserted for the purpose of pointing out several minerals, which would be accounted abroad as worthy of special attention. The list of natural productions which are used in the arts is daily enlarging, and soon very few of them will be passed by with indifference.

The iron ores do not appear in the above list, as they have been described so fully, that all the facts in relation to them have been stated.

CHAPTER XII.

On Drift. — Grooves and Scorings of the Rocks of the Second District. — Hypotheses. — Depression or Submergence, and Gradual Rise. — Glacial Theory. — Remarks on the necessity of a classification of facts, etc.

In this chapter, I propose to condense into one view the facts in relation to drift and the subjects related thereto, so far at least as they receive illustration in the geological structure of the Second district. For a full and clear understanding of these phenomena, it is necessary to bring together the facts relating to each, such as the distribution of boulders, the scoring of rocks, the position of the tertiary, etc. I shall therefore recapitulate briefly these facts, preparatory to summing up the inferences which may be deduced from them.

1. *Distribution of boulders.* It has been stated that the boulders and drift of the north are arranged in a belt between two and three hundred feet above the level of the great lakes, at the bases or upon the lower terraces of the hills which lie between the Champlain and the St. Lawrence waters. At least they are more abundant at this height than either below or above, though they occur between two and three thousand feet higher. Boulders may be divided into two classes: 1st, those which evidently belong to regions remote from their present location; and 2dly, those which belong either to the rock immediately beneath the surface, or to one but a short distance therefrom: the former class are rounded, and the latter angular. The boulders on the east side of Lake Champlain belong almost exclusively to the rock immediately below the surface, for which I shall be able to give a reason.

2. *The scorings of rock, or scratches.* Their direction conforms to that of the great valleys. In the Champlain valley, it is nearly north and south; and in the St. Lawrence valley, north-east and southwest. It is necessary to class with these the deep groovings noticed under Jefferson county (see p. 369). Perforations belong to another class of phenomena, being produced always by waters moving in eddying currents, and carrying around stones, sand and gravel.

3. *Tertiary of Champlain.* This is deposited from quiet waters, and always overlies the scored and grooved surfaces. It is marine, and contains many fossils and some boulders, but the latter are extremely rare except in a few places. In many places the tertiary lies beneath

the mass of boulders, but it is possible that both belong to one period. I have been unable, however, to discover, between the tertiary and the polished surfaces, any beds of boulders, or any formation like drift.

From the preceding facts, the four following inquiries naturally arise:

1. What were the agents immediately concerned in the transportation of drift and boulders?

2. What were the conditions of the surface immediately preceding and during the drift period, compared with the present?

3. What relations exist between the boulder system and the scorings of rocks?

4. Were any of the causes which were concerned in the transportation of boulders and drift concerned also as causes in the excavation of valleys?

The preceding inquiries, though stated under distinct heads, are so intimately related to each other, that neither can be discussed without involving the whole collectively, or without anticipating to some extent the answers which belong to each of the others:

1. The agents concerned in the transportation of drift and boulders are water and ice. The fine materials in which the boulders are imbedded consist mostly of the debris of the rocks in the immediate neighborhood, and hence are not as a whole of foreign origin. The boulders proper are foreign, and have been brought to the places where we now find them. The agent concerned in this work of transport is ice, either local or general. Icebergs, according to the opinion of the geologists of the present day, were the immediate agents concerned in transporting and distributing boulders. There is no necessity for occupying time in the discussion of this point, as no fact in geology is better established. But,

2. What then was the condition of the surface of that portion of New-York which lies between Lake Champlain and the St. Lawrence? Without giving a direct answer, I make this hypothesis, namely, that it was depressed; and that preceding the deposition of the tertiary, the country was low, and connected at the north with a wide and extensive region giving origin to large rivers, which flowed in succession over different parts of the region lying between the Champlain and the St. Lawrence. These rivers were wide, shallow, and swift in some parts of their course, and frequently formed new channels. They communicated with the Atlantic on the south, through the Champlain, Hudson and Mohawk valleys. They bore along ice loaded with sand, pebbles, etc., which scratched and grooved the surfaces of rocks over which they flowed, and were the agents also of perforating the rocks in the form of pot-holes.

I will state here, before I proceed further, why I prefer this hypothesis to others which have been advanced:

1. Icebergs, though loaded with boulders, are very poorly adapted to polish, groove or score rocks. The bottom of the ocean is not a bare rock, but is covered with mud and sand; and when the icebergs ground, it is in these soft materials, which, if they do not completely protect the surface of the rock beneath, yet by no means leave it to be marked or scratched in long parallel lines, like the surfaces we are considering. The motion of the icebergs, when they ground, is rotatory: they are not driven through the ocean, ploughing the surface of its rocks; but they carry boulders, and drop them in their course, and hence become probably the principal agents of distributing and transporting those masses.

2. The surface has been depressed, and rivers have coursed far and wide over land which is now elevated, and upon which none are now found. Proof of this is furnished in the numerous pot-holes in ledges of rock now distant from any stream, and far above all the creeks in the region.

3. There are long lines of gravel and sand in the form of ridges, which mark distinctly the former borders of lakes or seas.

4. The existence of the tertiary, a marine formation, now reclaimed by elevation, not by depression, or by the wearing down of barriers.

The hypothesis of wide shallow rivers answers better to existing phenomena than any other. We require running water, with a current capable of pushing along gravel and sand, for it is only by means of fine materials that we can obtain a smooth polished surface; and it is essential, too, that it should be borne along in one given direction for a long time, as in forming or channelling the deep grooves in the birdseye at Watertown (see Fig. 90, p. 369.)

Wherever I have observed these deep scorings, I have felt the necessity of calling in the aid of running water. Neither icebergs nor glaciers are at all fitted to produce phenomena of this kind or character, though they may scratch rocks; the latter especially must be ranked among the agents which produce this effect, but icebergs are among the more unimportant of those agents, and can by no means occupy a distinguished place as such in general.

Subsequent to this period when broad shallow rivers flowed over our land, it became submerged, and continued beneath the water of the ocean sufficiently long for the deposition of the tertiary. During this period, the free and open communication with the Arctic ocean permitted the ingress of icebergs, bearing the boulders of the north, the hypersthene rock, etc.; these stranded in the shallow waters which surrounded the central part of the now mountainous region, that of the Adirondacks. This condition, however, did not continue; the whole country was again elevated, and that not once for all, but by several successive upheaves, each followed by a long interval of rest; for we find the impressions of many different lines of coast, which serve to distinguish the periods of activity of the elevating force from those of its repose. This force was not violent, but it affected a wide extent of country: it was paroxysmal in its operation, and generally produced but a moderate degree of derangement in the region subjected to its influence; but occasional fractures were made, and surfaces which were previously marked by diluvial action, were disjoined, as may now be frequently observed in the valley of Lake Champlain. During the period when the tertiary was depositing, we have reason to believe that the space occupied by the great lakes was greatly enlarged; and that those depressions which had been made by large streams flowing through the shales of Jefferson county, were extended laterally by the action of waves.

The above hypothesis may appear complicated and unsatisfactory, and to some it may not appear why I have supposed the fluviatile era should precede the marine. I remark, that this is essential; for the scorings of the rocks cannot have taken place since the marine era: they must have been made previous to the deposition of the tertiary, and the whole country has since been submerged, and afterwards raised and reclaimed. The groovings leading from Watertown to Lake Ontario must have also been made before the tertiary deposit; and the

same agent which performed this work must also have excavated to some extent the shales then overlying the trenton limestone which forms a part of the floor of Lake Ontario. Afterwards we have the marine deposit; and then the ocean must have occupied the present floor of the lake, and widened the breach already existing in these soft shales.

I have now answered the inquiries I proposed:

1. In regard to the transportation of the northern boulders; the principal agents, I have stated, were icebergs.

2. The surface previous to the boulder period, I have stated, must have been depressed, and according to hypothesis, may have been overflowed by wide shallow rivers.

3. The scorings of the rocks took place previous to the boulder era; or at least it is a work which may have been done by rapid currents bearing along gravel, sand, and ice occasionally loaded with stones; but it is a phenomenon which, in the main, is independent of the action of icebergs.

4. I have stated that the valleys now containing our great northern and western lakes, were excavated partly by broad shallow rivers, but probably widened by the action of the sea at the period of the deposit of the tertiary; during which period, icebergs floated from the north, and transported most of the boulders which we now find upon this section.

In the preceding remarks, I had in view the country which forms the Second district, and the hypothesis I have proposed accords best with the phenomena I have observed in this region. I can, by no other hypothesis, explain the phenomena so satisfactorily as by the preceding. The fact of its submergence for a time, or during the deposit of the tertiary, does not make provision for the scorings and groovings of rocks in the mode we now find them; and hence the hypothesis must go back farther, to a time when I have supposed a condition of the surface favorable to the existence of broad shallow rivers, which frequently changed their beds and channels, in consequence of the oscillations produced by disturbing forces.

In the progress of the Survey, I have felt the necessity of modifying previous views in relation to the cause or causes which have scored the surface of rocks so widely and extensively; and instead of seeking one cause, by which this phenomenon may have been produced, and which may be applied to the whole country, or to the entire northern hemisphere, I have found several; adopting in this respect the same rule of interpretation that I have in relation to the distribution of the boulders, drift, and all the loose materials; for these materials can by no means have been all distributed by one single agent. So the scratches upon rocks may have been produced, 1st, by the currents of river bearing along gravel and sand, and at times ice and boulders; 2dly, by glaciers;* and 3dly, by icebergs with implanted boulders, though not generally. The latter were the true agents in the distribution of northern boulders, while the northern part of New-York was submerged. And here I take the opportunity of saying,

* Essays of Venetz, Charpentier and Agassiz. Not that I can apply the glacier theory to the northern district. I mention it here as a cause, which, in its own field, produces these effects.

that the views of Mr. Murchison* in this particular accord with all that I have observed in the Second district.

There remains one fact to be explained, namely, the removal in many places of the upper part of the tertiary; for it is only, as has been stated, perfect or entire in some sheltered places. It is swept away by some cause; and though I have suggested in several places in the report, that a current swept over the country, and bore the tertiary along south, yet this explanation is not very satisfactory. I would rather adopt the opinion or theory, that during its rise, after its submergence and the completion of its beds, they were destroyed by the action of waves; and I take this opportunity to say that I am the more inclined to the latter, inasmuch as I wish to see things done in the most quiet way possible. I care not how long it takes. I have even been inclined to exclude from my list of causes, those mighty waves, enormous debacles, and hemispheres capped with ice; they have always appeared to me to be out of keeping with the order of things established on this planet.

The boulder system of the western slope of the Green mountains, although in proximity to that of New-York, is quite different from it. The Taconic rocks, together with the Champlain group of the New-York system, form this slope. This system I have described as narrow and long; and although it extends far north and south, yet I have been unable to discover upon this belt the boulders which abound west of Lake Champlain.

We may divide the region which lies between the western shore of the St. Lawrence, and the eastern limit of the Taconic system, into three belts running north and south: The eastern belt takes in the western slope of the Green mountains, and parts of the valleys of Lake Champlain and the Hudson river; the middle belt commences on the east with the eastern slope of the northern highlands, and extends to their western slope; and the western belt comprises the valley of the St. Lawrence, and the region extending along the southern border of Lake Ontario to the foot of Lake Erie. In the first, the boulders of the rocks of the Taconic system prevail. At this moment, I do not remember to have seen a rock of granite, hornblende, hypersthene or primary limestone, except upon the very eastern border, where it lies adjacent to the granite of the Green mountains. The middle belt abounds, from the northern slope into Canada, quite down to the Sound, with hypersthene, gneiss, hornblende and primary limestone. The western belt is distinguished by hypersthene, and the granites of the far north.

The hypersthene boulders abound, as has been stated, on the shores of the St. Lawrence and Ontario; and are found far south in Erie county. Their origin is clearly not in Essex county; for in that case, as has been stated, we should be able to trace them to their source, along the western slope of the mountains, up to their parent rock in that county, just as we can trace those which are found on the southern slope of the same mountains.

The point of greatest interest to myself among these facts, relates to the extreme narrowness of the belt occupied by any given system of boulders; which fact seems to be demonstrated, if reliance can be placed upon the observations already made.

* Murchison's Address at the Anniversary Meeting of the G. S. of London, 18th February, 1842.

In ascending from facts to causes, it is necessary to classify whenever it is possible; to arrange together the phenomena which resemble each other, and to separate those which offer a dissimilarity in their origin. From the observations of geologists on both sides of the Atlantic, it is not difficult to see that it would be absurd to place all hills of sand and pebbles, or ridges of the same materials, and collections of boulders, in one class. The truth is, a variety of causes have operated in their production; and geologists, in attempting to assign a cause which should cover the whole ground, have erred. In finding, in our long lines or ridges of rounded stone and gravel, evidences of glacial action, they have overlooked the fact that all bodies of water throw up such ridges. In explaining scratches or groovings of rocks by icebergs, they do not seem to have observed that the bottom of seas is covered with a thick bed of soft materials, capable of defending the rocks from such markings. In supposing the northern hemisphere to have been capped with ice, converting all the water to a solid mass, they forget that such a condition is incompatible with life, that there must necessarily have followed an entire extinction of all organic beings, and that there would have been a gap in the series; but we do not find this to be the case. There is a perfection apparently in the chain; it is not broken just at the dawn of the present era, as is proved by the fossils of the tertiary. As we find, therefore, phenomena very similar, but produced by very different causes, so our theoretic generalizations should correspond. In the grooving of rocks, we admit a variety of agents: so, in the accumulations of loose materials, we must do the same; and when we have sufficiently observed to classify correctly the results, we shall be able to comprehend the causes which have modified the surface, and to explain what each has effected in its own sphere and capacity.

TABULAR VIEW

OF THE

SEDIMENTARY ROCKS OF NEW-YORK.

TACONIC SYSTEM,		Taconic slate, Magnesian slate, Stockbridge limestone, Granular quartz.
NEW-YORK SYSTEM,	CHAMPLAIN GROUP,	Potsdam sandstone, Calciferous sandrock, Chazy and Birdseye limestone, Marble of Isle La Motte, Trenton limestone, Utica slate, Loraine shales. Grey sandstone, Conglomerate.
	ONTARIO GROUP,	Medina sandstone, Green shales and Oolitic iron ore, Niagara limestone, Red shale, Onondaga salt and plaster rocks, Manlius water-lime.
	HELDERBERG SERIES,	Pentamerus limestone, Delthyris shaly limestone, Oriskany sandstone, Encrinal limestone, Cauda-galli grit, Schoharie grit, Helderberg limestone.
	ERIE GROUP,	Marcellus and Hamilton shales, Tully limestone, Genesee slate, Ithaca and Chemung shales and grits.
OLD RED SYSTEM,		Old Red sandstone, with its beds of conglomerate, and its greenish shales of the Catskill mountains.
NEW RED SYSTEM,		New Red sandstone, associated with volcanic rocks or greenstone trap of the Palisades.
TERTIARY,		Blue and yellowish clays of Champlain, and white and yellowish sand.

LIST OF ENGRAVINGS.

VIEWS AND SKETCHES, SCENOGRAPHICAL, TOPOGRAPHICAL AND GEOLOGICAL.

GEOLOGICAL MAP.

This map represents accurately the general boundaries of the rocks, but it has been impossible to exhibit all the facts which are of considerable interest. The confined dimensions of the map prevented any attempt to give much more than the geographical extent of the rocks; and besides it appeared inexpedient to exhibit the topography of many of the masses, such as beds of iron ore, dykes, etc., on account of the inaccuracy of all the existing maps of the State, more particularly those of the northern district. The coloring conforms mostly to the system now adopted for all maps of this kind: where differences exist, the explanations are given on the map itself.

FOSSILS REPRESENTED IN THE WOODCUTS.

* DESCRIPTION FURNISHED BY DR. JAMES EIGHTS.

SPHÆROMA. *Latreille.*

Antennæ four, very distinct, setaceous, terminated by a multiarticulate filament; the lower pair longer than the upper, and inserted beneath its basal joint. The anterior portion of the head, situated beneath the antennæ, is rudely triangular. The mouth, as usual to the Isopods. The tail is composed of but two complete and mobile segments; the first of which, however, exhibits impressed and transverse lines, indicating vestiges of the usual number of segments. The subcaudal branchiæ are soft, naked, and disposed longitudinally in pairs; these appendages are curved inwards, and the inner side of the anterior pair is accompanied in the males with a small linear and elongated piece. The posterior extremity of the animal, on each side, is furnished with a swimmeret, terminated by two plates, the inferior one alone moveable; the upper is formed by an external elongation of the common support.

S. BUMASTIFORMIS, *Eights.*

Animal subovate, oblong, very smooth, not serrated. Color olivaceous green; under side, legs, and segmentary margins, pale ochraceous. Head a transverse square, inserted in a notch of the first abdominal segment. Eyes lateral, reniform, closely approximating to the anterior portion of the first segment. Superior antennæ slightly longer than the head, three-jointed; the basal joint subangular, much enlarged, and solid; terminating filament composed of numerous small and short articulations. Inferior antennæ nearly double the length of the upper, four-jointed, and ending with numerous short and smaller joints. Abdomen articulated into seven subequal segments, each containing beneath a pair of perfect legs. Legs rather stout, each terminated by a strong slightly incurved nail. The segmentary impressed lines on the basal segment of the tail do not extend to its lateral edges; the terminating segment is triangular, and entire. The swimming fins are much depressed; the superior one extends nearly the length of the segment; the lower one is about two-thirds its length, and closes in under the superior one similar to the sticks of a fan. The subcaudal branchial laminæ are bifid; one portion articulating on the other, not unlike the palpi on the jaw appendages. These laminæ are eight in number.

In consequence of the near resemblance of this animal to the fossil genus *Bumastus*, it has received its specific appellation. When in a state of contraction, it assumes the form of a ball.

Found in considerable abundance in pools left by the receding tides, along the shores of Cape Horn and its adjacent islands.

DESCRIPTION OF PLATES.

PLATE I.

Fig. 1. Tellina calcarea (Beauport, Canada). — 2. Terebratula psittacea (Beauport, Canada). — Valves although delicate and thin, yet are perfect and unbroken, and frequently both in position. — 3. Tellina grœnlandica. Common the whole length of Lake Champlain. — 4. Pecten islandicus (Beauport). — 5. Saxicava rugosa. Common the whole length of Lake Champlain. At Beauport it forms a mass ten feet thick, made up almost wholly of this species. This, with Tellina grœnlandica, is found on the St. Lawrence at Ogdensburgh. — 6. Patella. — 7. Undetermined. — 8. Mya truncata, abundant at Beauport. — 9. Mya ——. — 10. Mytilus edulis. This was pronounced by Mr. Conrad a Modiola, and it was thus given in the annual reports. It is abundant at Port Kent. It is a thinner shell than the one found at Uddervalla in Sweden.

PLATE II.

Fig. 1. Tritonium anglicum (Beauport). It is found recent at Portland in Maine. — 2. Tritonium? — 3. Tritonium fornicatum. — 4. Scalaria borealis. — 5. Undetermined. — 6. Astarte (Portland). — 7. Natica clausa (Beauport). The recent species abundant on the Atlantic coast. — 8. Velutina galericulata. Brown. (Rare at Beauport.) — 9. Mya arenaria. Common at several places on Lake Champlain, and at Lubec in Maine. — 10. Turritella. — 11. Elongated valves of the Balanus miser? (Beauport). — 12. Nucula portlandica. — 13. Bulla. — 14. Undetermined.

PLATE III.

Ground plan of the veins of magnetic oxide of iron at Adirondack. The Adirondack river cuts through the hypersthene rock. The ore appears on each side, and apparently passes beneath the rock. It sends out from the main mass a narrow vein, as represented in the plate, running S. 25° E. Natural joints and divisional seams are represented in the plate.

PLATE IV.

This represents the relative position of all the veins of ore which have been discovered at Adirondack. They all disappear beneath the hypersthene, and no regular walls have yet been found.

PLATE V.

The ground plan of the veins of lead at Rossie are laid down in this plate from actual survey.

PLATE VI.

Fig. 1. is a section of the west side of Lake Champlain, extending from Whitehall to St. Johns. It exhibits the position of all the rocks between these places. The primary upon the section marks the termination of the great ranges of mountains which come from the southwest.

Fig. 2, is a section from St. Johns to La Prairie. It is mostly level. It passes over the Loraine shales.

Fig. 3, is a transverse section, or an east and west section from Lake Memphremagog to the St. Lawrence river, nearly on the latitude of 45°. In New-York, it passes over the northern slope, and is underlaid mostly by the Potsdam sandstone.

PLATE VII.

The sections of this plate are all transverse, or east and west sections, parallel with Fig. 3, Plate VI.

PLATE VIII.

Sections illustrating the geological structure of Essex county.

Fig. 1, is nearly upon the travelled road from Crown-Point Landing to the Old Fortress.

Fig. 2, lies upon the lake shore. It is intended to exhibit the position of the porphyry, and the uplift of the Chazy limestone, south of the village of Essex.

Fig. 3, is an east and west section.

Fig. 4, extends from Split-rock about three-quarters of a mile west, embracing one of the porphyry beds, and terminating with Trenton limestone.

Fig. 5, is a section from the mouth of the Ausable river to Trembleau point at Port Kent, where the tertiary rests upon the Hypersthene rock and Potsdam sandstone.

Fig. 6, shows the relations of the porphyry and Utica slate.

Fig. 7, shows the uplift at Essex village, together with the remarkable undulations and fractures in the upper part of the Trenton limestone.

PLATE IX.

Section illustrating the geological structure of St. Lawrence county.

The sections pass over a country in which the rock is very much concealed by drift and boulders. No rock higher in the series than the Calciferous sandrock, appears in any part of the county. Towards the primary region, boulders become larger as well as more numerous.

Figs. 3 and 4 may be considered as one or two distinct sections, as the line is continuous from Nicholville to Massena.

PLATE X.

Sections illustrating the geological structure of Jefferson county.

Fig. 1, is a section extending from Watertown southeast to Loraine. The rocks passed over are the Birdseye, Isle la Motte marble and Trenton limestone, all of which appear in the bank of the river at Watertown. The series on this section terminates at Loraine, in the shales of Loraine, and the Grey sandstone. Dip S.W.

Fig. 2. *Section from Alexandria to Rodman.* The direction is nearly southeast, passing through Orleans and Brownville. It commences on the primary, and terminates in the same rocks as the preceding.

Fig. 3. *Section extending southeast four miles from Watertown.* It embraces only the Birdseye, Isle la Motte marble, and Trenton limestone. Dip S.W.

Fig. 4. *Section from French creek to Depauville.* Direction nearly east and west; distance ten miles. Rocks dip only slightly southwest; undisturbed, but have been remarkably waterworn. Section crosses the excavations.

PLATE XI.

Sections explanatory of the Taconic system.

The sections of this plate run east and west, and pass over about fifteen miles, except Fig. 5, which extends only seven miles. The relative position of all the masses has not been made out, particularly the Taconic slate and those of the Hudson river, and then again the position of the granular quartz and the Stockbridge limestone; at some points, the former appears embraced in the latter. The limestones occupy uniformly the valleys as represented in all the sections, which are produced by the joint operation of uplifts and diluvial action. In Fig. 5, there are numerous uplifts in the shales east of Lake Champlain; the same mass appears at several points in the direction of the section. The coloring is the same as upon the other sections: the primary, lake; the limestones, blue; the quartz, brown; the slates, black or dark; and those of the Champlain group, purple. The distinctions of color in the Taconic system are only faintly marked.

PLATE XII.

Sections of Clinton county.

Fig. 1. Section extending from Plattsburgh to Redford, twenty-two miles. Dip of the rock east, but concealed by drift towards Redford.

Fig. 2. is a section of half a mile, near Chazy village. It is intended to show the large development of the Calciferous sandrock, and the relation of the masses which compose the rock.

Fig. 3, shows the relation of the rocks extending from Chazy village to the landing.

Fig. 4. This section extends over the Hudson river shales and sandstones on the eastern shore of the lake, nearly opposite Chazy.

PLATES XIII., XIV., XV.,

Are pictorial views in the interior of Hamilton county: they were taken by Mr. Hill.

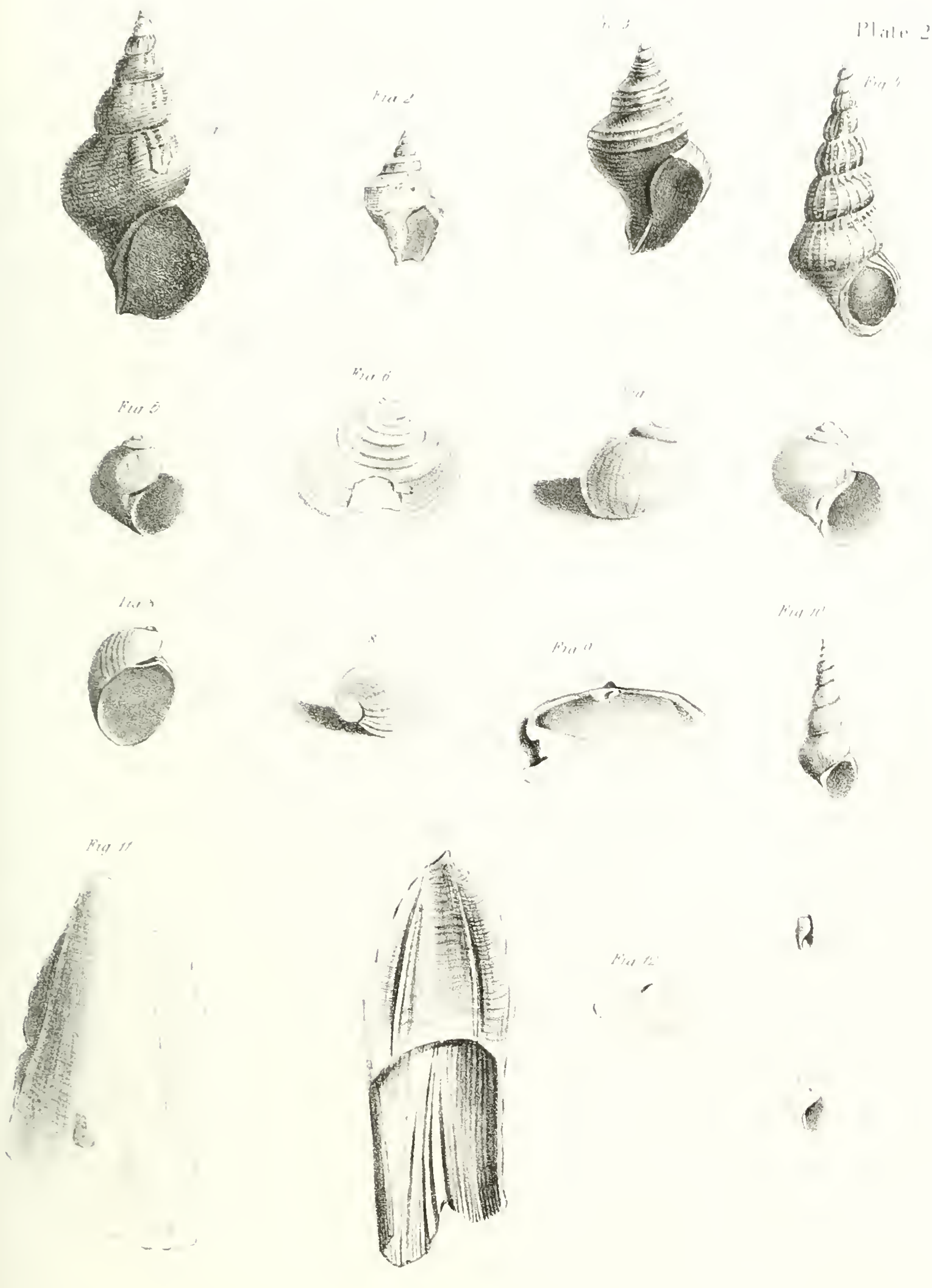
The reduced maps of Jefferson and Clinton are intended to exhibit the relation of the rocks composing the Champlain group. Their coloring corresponds in the main with the large map accompanying the Geological Reports.

Plate 1

E. Emmons

Lith of Endicott, New York

Plate 2



E. Emmons

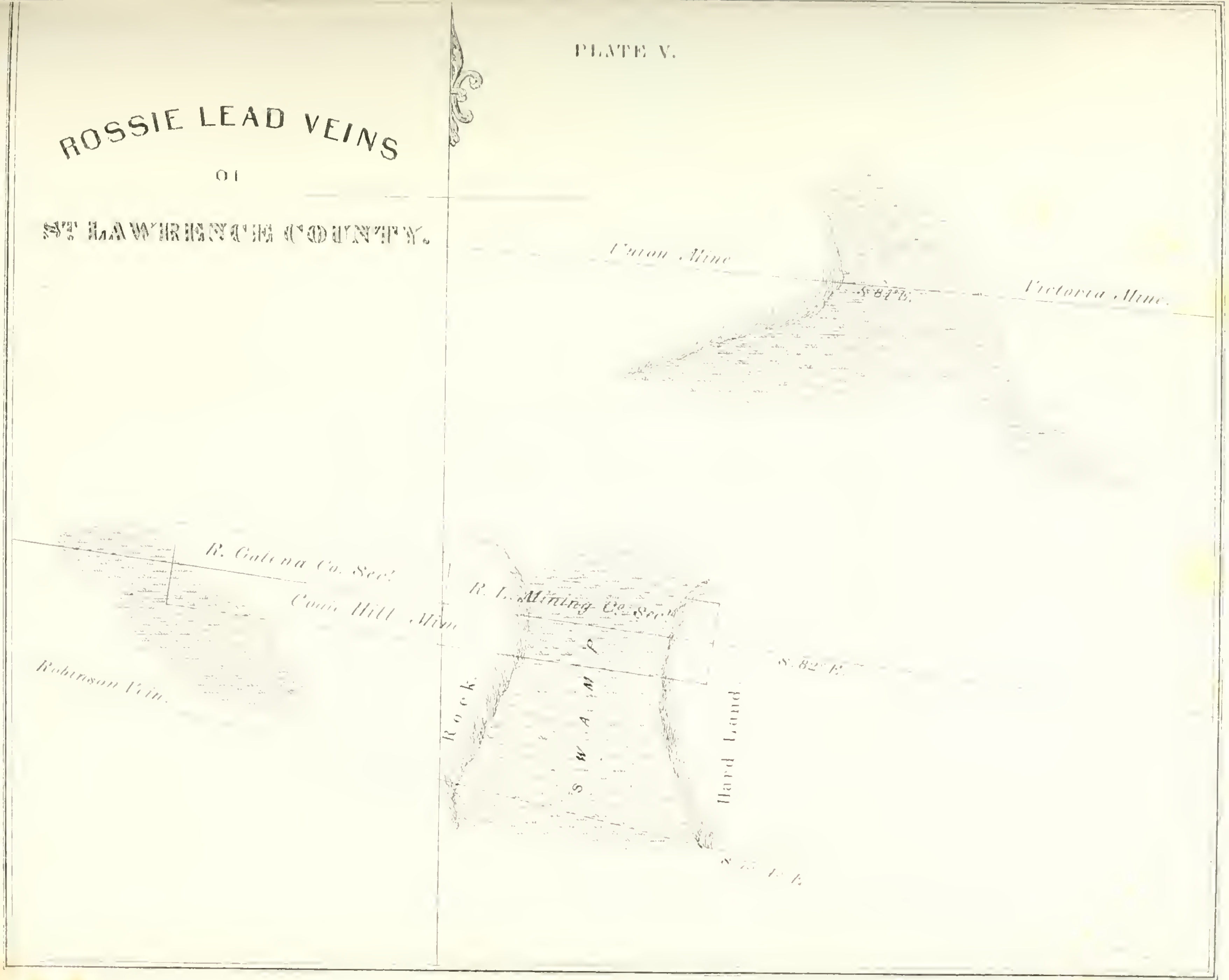
Lith. of ... New York

PLATE V.

ROSSIE LEAD VEINS

OF

ST. LAWRENCE COUNTY.



Lith of Endicott N York

VIEW ON CEDAR RIVER, HAMILTON COUNTY.

GEOLOGICAL MAP
OF
CLINTON
COUNTY